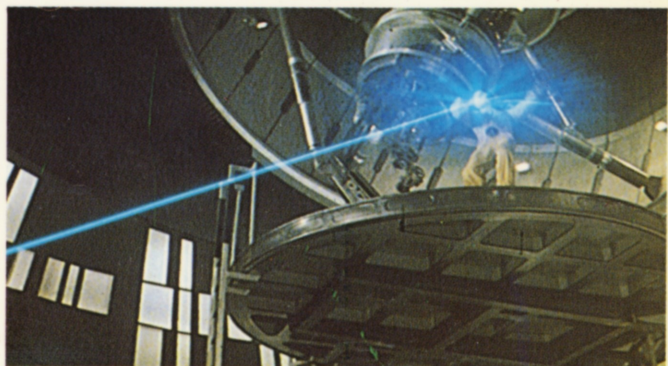


STARLOG *photo guidebook*

SPECIAL

Vol. 3

EFFECTS



Norman Jacobs and Kerry O'Quinn present

SPECIAL Vol. 3 EFFECTS

By David Hutchison

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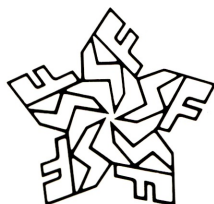
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ABOUT THE COVER:

Front Cover, clockwise from top right: 1) Superman is up, up and away via Zoran Perisic's Zoptic front projection technique. 2) Live laser effects under the supervision of Derek Meddings on *Moonraker*. 3) Bran Ferren's optical enhancement of Dick Smith's makeup in *Altered States*. 4) Doug Trumbull pauses a moment with one of the droids from his *Silent Running*. 5) Miniature from *The Black Hole*, effects by Art Cruickshank, Peter Ellenshaw, Danny Lee and Eustace Lycett.

Back Cover, clockwise from top: 1) Miniature sequence from *Thunderbirds*, "End of the Road," special effects supervised by Derek Meddings. 2) One of the optical printers at John Dykstra's Apogee Co. 3) The model "Galactica" rigged for filming on the Dykstraflex motion control system. David Robin and Don Dow are shown next to the model at Apogee. 4) Leon Harris' conceptual art for the original alien saucer sequence at the end of Disney's *Watcher In the Woods*. This sequence was never filmed.



A STARLOG PRESS PUBLICATION

475 Park Avenue South
New York, N.Y. 10016

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PREFACE

This is the third volume in the STARLOG Photo Guidebook Series on Special Effects. Subtitled "High Tech Filmmaking," it focuses on the modern gadgetry used by special effects houses to make photographic effects faster, easier, cheaper...and more complicated. New advances in special effects technology are coming so fast that by the time news reaches the printed page, something better has already come along. Selecting material for this volume, with so much happening so fast, was a tough challenge. Finding material, stories and illustrations was no problem; trying to decide what to *leave out* was a problem. I could have easily filled a three-volume series on High Tech Filmmaking alone. So take a moment to explore the film technology of today and tomorrow, from computer cameras to 3-D to miniature technology. But as you read through this book, keep in mind the fact that somewhere, someone is thinking up something even better for filmmakers and moviegoers alike.

David Hutchison
STARLOG Magazine

ACKNOWLEDGEMENT

This third volume of STARLOG's Photo Guidebook to Special Effects could not have been assembled without the generous assistance of the science-fiction/fantasy collectors and the special-effects artists themselves, many of whom took the time to lend photographs from their collections and take the time to tell the stories behind them. My personal thanks to: Nick Allder, James Butterfield, Larry Cuba, Jim Dow, Richard Edlund, Bran Ferren, George Gibbs, Barry Gordon, David English, Mat Irvine, Don Iwerks, Brian Johnson, Murray Lerner, Carey Melcher, John Rupkalvis, Dan Symmes, Doug Trumbull, Fran Van der Veer, Richard Vetter and Joe Viskocil.

CONTENTS

The Digital Brush	10
Disney's Calculating Camera	16
Magicam Explores the Cosmos	24
Quo Vadis 3-D?	33
Allder and Johnson: Special FX Supervisors	40
Letter From England, I	46
Sodium System Traveling Mattes	50
Flying Down to Mongo	52
Art, Science and Altered States.....	62
Show Scan	72
StereoSpace	76
Elicon	78
Letter From England, II	80
Explosions for Miniatures	84
Building An Effects Shop For "The Empire"	90

INDEX

Titles:

ALIEN	40-45	Mary Poppins	50-51
Altered States	62-71	Medusa Touch, The	40, 42
A Man for All Seasons	42	Melody	34
Ape	35	Mosquito Squadron, The	42
Black Hole, The	16-23	New Scotland Yard	42
Blockhouse, The	42	Nothing but the Night	42
Bubble, The	35	Pink Panther, The	40
Chitty Chitty Bang Bang	84	Protectors, The	42
Close Encounters of the Third Kind	59, 84	Revenge of the Creature	35
Cosmos	24-32	Revenge of the Pink Panther	42
Crucifer of Blood	65	Sea Dream	33, 39
Day After Tomorrow, The	42	Space: 1999	42
Demon Seed	15	Star Wars	10-15, 18, 45, 52, 84-90, 96-98
Dial "M" for Murder	33	Stingray	42
Dr. Who	80-83	Superman	52, 54
Dynasty	35	Tamarind Seed, The	42
Empire Strikes Back, The	40, 42, 45, 90-98	Taste the Blood of Dracula	42
Evita	65	This Island Earth	84, 89
Fire in the Sky	88	Thunderbirds	42
Flash Gordon	46-49, 52-61	20,000 Leagues Under the Sea	16, 18
Flesh Gordon	84, 87	2001: A Space Odyssey	42
Frankenstein	65	Trip to the Moon, A	84
Greatest American Hero, The	30, 31	UFO: Target Earth	15
It Came From Outer Space	33, 34	War of the Worlds	84, 87
Khartoum	42	Watcher in the Woods	20
Kiss Me Kate	33	When Dinosaurs Ruled the Earth	42
Logan's Run	84	When Worlds Collide	84

Artists:

Alder, Nick	40-45	Johnston, Joe	92
Anderson, Gerry	40, 42, 88	Komar, Victor	39
Berg, John	97	Kurtz, Gary	42
Bower, Martin	46, 48	Lerner, Murray	35, 36, 37
Bowie, Les	42	Logan, Bruce	89
Butterfield, James	37, 38, 39	Lucas, George	10, 12, 13, 40
Caple, Ray	45	Lumm, Charles	80
Carroll, Gordon	40	Lycett, Eustace	18
Chomitz, Tom	13	Melcher, Carey	24, 28-31, 32
Cobb, Ron	44	Miller, Al	93
Condon, Chris	39	Muren, Dennis	92
Conway, Richard	46, 49, 59	Nicholson, Bruce	97
Cruickshank, Art	18	O'Donnell, T.J.	13
Cuba, Larry	10-15	Overs, Christine	46
DeFanti, Tom	14	Pearson, Bill	46, 48
Dow, Jim	24, 26-31, 32	Peterson, Lorne	92
Dykstra, John	12, 90	Retsek, John	24
Edlund, Richard	90-98	Rupkalvis, John	37
Ellenshaw, Peter	18	Sagan, Carl	24, 28-32
Ferren, Bran	62-71	Scherman, Tom	87
Foss, Chris	44	Scott, Ridley	40-44
FrieseGreen, William	33	Smith, Dick	64-65
Gibbs, George	46-49	Snyder, David	23
Giger, H.R.	44	Spence, Steve	48
Grafton, David	93	Spielberg, Steven	75
Hill, Walter	40	Symmes, Daniel	39
Hodges, Mike	48, 49, 61	Tippet, Phil	97
Inglish, David	18-23	Trumbull, Doug	59, 72-75
Irvine, Mat	78-81	Van der Veer, Frank	52-61
Iwerks, Don	16-23	Vanlint, Derek	45
Jefress, Jerry	93	Viskocil, Joe	84-89
Johnson, Brian	40-45	Watson, David	46

THE DIGITAL BRUSH

An Interview With Star Wars Animator, Larry Cuba

On the shifting sands of Tatooine nestles the small cottage of "Old Ben" Kenobi. Inside, Luke Skywalker and Ben listen to Princess Leia's plea for help via a holographic recording implanted in R2-D2. Also within the feisty 'droid's memory banks are the technical read-outs of the battle station *Deathstar*. These plans may sway the balance of survival for Princess Leia's people in the fight against the Empire!

The man responsible for the physical creation of the little 'droid's memory readout is Larry Cuba. The sequence in the briefing room in which the schematic view of the *Deathstar* appears on a huge electronic screen, displaying a simulated point of view of a pilot maneuvering straight down a trench on the surface of the *Deathstar* to a two-meter wide thermal exhaust port, was accomplished by means of computer animation.

Computer animation is a process whereby the illusion of movement is bestowed upon inanimate objects by

electronic means. In cel animation, an artist must draw each frame of film by hand. Here the computer creates each frame which is then photographed and projected. (Or videotaped and televised.)

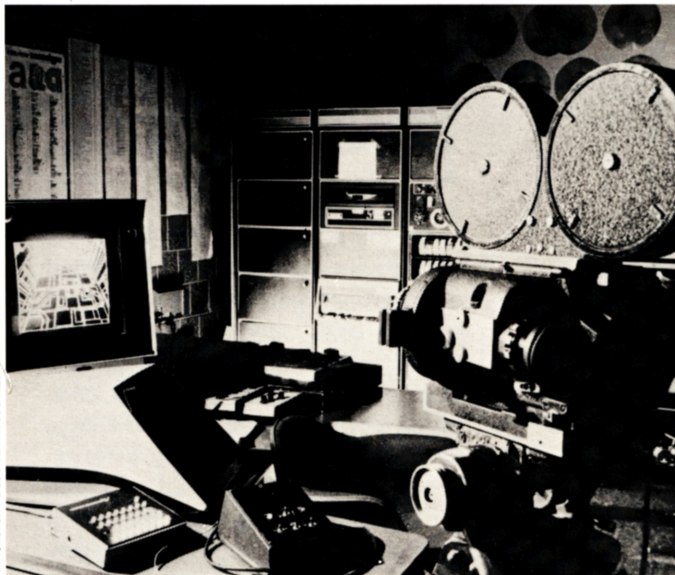
With *Star Wars* already in production, George Lucas issued a call for bids from companies and individuals to produce various bits of instrumentation animation—in particular the briefing room sequence. A number of computer artists and some cel animators responded.

Some of the computer people had very sophisticated equipment capable of producing colored and shaded planes and forms. One computer artist even wanted to do most of the model sequences entirely on computers. George spoke with each of the artists and viewed their work, but Larry seemed to understand the kind of look that George wanted for the film.

When Larry was assigned the computer realization of the *Deathstar* plans for the briefing room scene, he was asked to have the se-



Scene 135 from *A New Hope* (Chapter 4 of the *Star Wars* films) with the rebel starpilots and navigators viewing the rear-projected computer readout of the *Deathstar* plans. George Lucas preferred rear-projection on the set, so the actors would have something to play to.



Above: Larry Cuba's setup for the animation of the *Deathstar* plans. The PDP 11/45 is in the rear with the Mitchell camera aimed at the Vector General screen. **Right:** One frame of animation.

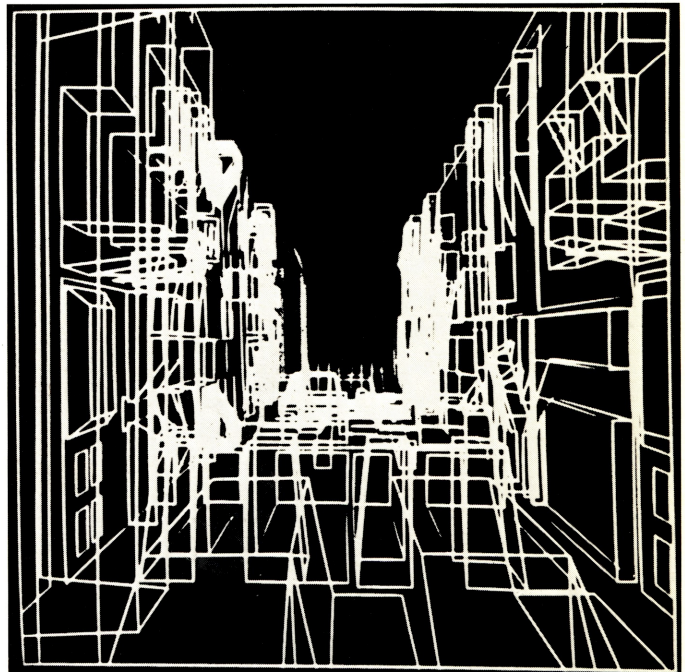


PHOTO: © 1977 20TH CENTURY-FOX

quence photographed on 35mm film so the plans could be rear-projected during the filming of the briefing room scene with the rebel pilots. At UICC Larry would be using the Vector General 3D3I display and a PDP 1145 minicomputer. The sequence would be filmed off of the Vector General screen with a standard Mitchell 35mm camera rigged with an animation motor. The only thing lacking was the trench. John Dykstra's crew had not yet gotten around to building it.

John Dykstra and his team of model-makers at Industrial Light and Magic (ILM) had begun to assemble the basic modular molds from which they would construct the model of the trench. The basic molds were constructed about two feet square in six different types. From

these molds hundreds of casts were made in polyurethane foam. These modular sections were then cut up and assembled in a variety of basically random configurations to establish the sides and bottom of the trench as well as part of the *Death-star's* surface area.

Larry took samples of each of the six to Chicago to construct his own computer trench. "There was no reason to have the computer sequence match the actual model precisely, since the audience would perceive the trench more in terms of a texture rather than an absolute configuration," Larry explains. "ILM was chopping up the modular pieces to assemble the trench, so I did the same thing—building up the trench in the computer just like they were doing with the real thing.

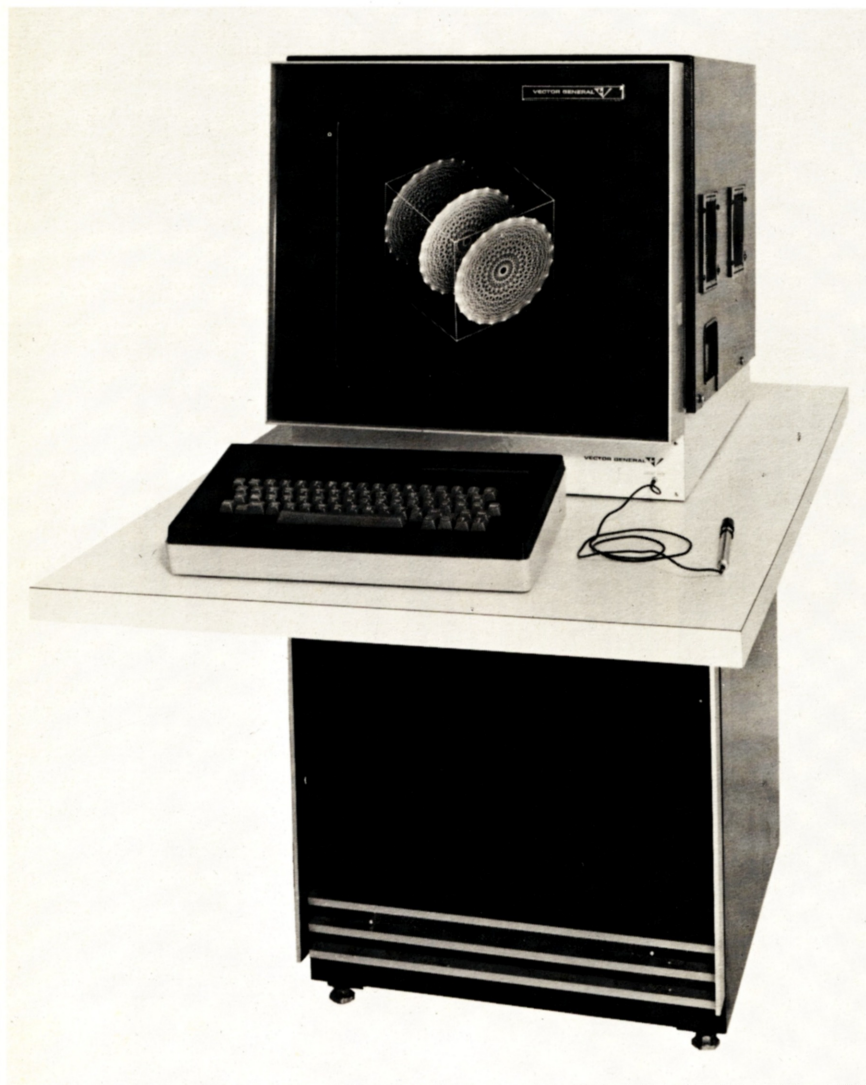
I photographed the six modules and traced them onto the Vector General data tablet with its electronic pen. By pressing the pen to the various points on the photographs, the modules were digitized—their x and y components entered into the computer." (The x component refers to the horizontal axis and the y to the vertical axis.) The z coordinate was entered manually.

The z coordinate (depth) was limited to about four or five different levels, so when entering the x and y components on the electronic tablet, Larry punched one of five buttons that he had programmed to represent the z coordinate at various levels.

"Then a program was written so that I could call up (from the computer's memory) the raw sections and combine them into the trench." The computer trench consisted of about fifty U-shaped sections (the two sides and bottom of the trench make a U). Larry called up sections of the modules, stretched or moved them around to build up the trench bit by bit. "The trench information was stored away and another program written that would call up the sections sequentially, in the perspective of a pilot flying down the trench, and cue the camera to photograph a frame. I managed to get about thirty frames an hour into the camera once the program was running smoothly."

On the screen the *Star Wars* audience sees the computer realization of the trench sequence in the form of a "wire cage" model rather than as a series of solid forms and planes. One of the early problems in computer graphics was the wire cage versus solid form display. At first computer programs could only call up figures in wire cage format. It was only a few years ago that programs were devised to remove the "hidden lines;" the program had to determine which lines would be "hidden" by a front surface or plane and remove those lines.

"When George Lucas specified the kind of animation he wanted for the scene, he knew enough about computer animation to ask for a true



The Vector General Series 3's capabilities range from a simple two-dimensional graphics display to complex 3D transformations including scale, rotation about all three spatial axes and variable intensity for depth cuing.



Dolphin Productions of New York City is justifiably famous for its Pepto-Bismol spot that dramatically inflates a "hard-hat" afflicted with indigestion—all by means of the Scanimate electronic video synthesizer.

perspective without the 'hidden lines' removed. He wanted the trench and the *Deathstar* to appear as wire cage figures with all lines and vertices visible. George thought that this sort of image would suggest 'computer animation' by having a very mechanical look."

Science fiction as a genre often projects into the world of future technology. Larry Cuba suggests that in the future computers will be able to generate pictures of such quality that they will look as though they had been photographed by a camera. In the case of *Star Wars*, it was thought that such photographic realism might be confusing to the audience, so a wire cage model was specified so that the audience would readily understand that the images

were to have been created by a machine.

From start to finish, the entire sequence lasts only about 40 seconds on the screen. It took Larry and his two assistants T.J. O'Donnell and Tom Chomitz about two months to supply two minutes of animation.

The enormous number of points and lines on the wire cage figures that make up the representation of trench seem to flow with almost simultaneous precision. The computer doesn't handle all of these points simultaneously, but rather sequentially. It happens very fast, certainly, and it can appear to the eye to be happening all at the same time, which would be the case while observing a real-time system. A real-time system means that the com-

puter is drawing successive frames as fast as thirty-per-second, which is what is needed to see the thing move smoothly on a TV screen. "There is a limit to how many of those points a computer can draw in a thirtieth of a second and in the case of the *Star Wars* animation with its true perspective image as opposed to parallel projection (one without depth cueing), I went way beyond that limit. Consequently, you take longer than a thirtieth of a second to put an image on a frame of film. Since the *Star Wars* sequence was being filmed it didn't need to exist in real time anyway. In this case it took about two minutes to complete each frame."

There are, of course, displays more sophisticated than the Vector

General, that could have computed the perspective more readily and probably done the flight down the trench in real time; the perspective transformation would be wired into the hardware itself, rather than generated by a separate program

There are systems today that can generate shaded color planes in real time. One such system was developed by General Electric and built at a cost of \$2,000,000 to train astronauts to land on the Moon. Similar systems are used to train airline pilots to land under a variety of emergency conditions.

Basically, Larry's system consisted of a \$50,000 Vector General 3D3I graphics terminal with its dials and electronic data tablet, a \$30,000 PDP 1145 minicomputer and standard alpha-numeric keyboard. "I set up a Mitchell 35mm camera with an animation motor in front of the screen and connected it to the computer so that a signal from the program could trigger the animation motor when the image was complete.

"The full length of the trench consisted of about fifty of these U-shaped sections. Well, you couldn't bring all fifty of these sections up on the screen at the same time. The computer brought up five sections at a time and it would take about 24 frames (one second) to go through one U-shaped section of the trench.

"So it was this continual shuffle of sections; never having more than five on at any one time. Now, of course, this means that ones at the back just sort of pop on. I had hoped to be able to just fade them in, bit by bit, by manipulating the intensity control to make them appear more slowly. But there wasn't enough time.

"The entire sequence was shot once, and that was it. Early on, I had a deadline of June first, but in early April the deadline was moved up to May fifth—lopping off three weeks. I had anticipated another six. I suggested that they wait and shoot the sequence in England blue screen; they could print the computer effects in later and have the thing perfect. But no, they wanted to rear

project it so that the guys in the briefing room would play to the images while they were talking. Well, my first take worked. There were a couple of problems, but they edited around them."

The briefing room sequence is the only scene in *Star Wars* in which digital computer animation was used—other than for occasional background displays as part of the *Deathstar* set. The effect was programmed in Tom Defanti's GRASS language. GRASS (GRAPHICS Symbiosis System) was written by Tom as part of his doctoral thesis for Ohio State. "It takes advantage of all the things that the Vector General does. The Vector General has a lot of image transformation hardware built into it, which allows you to do a lot of things in real time (with no processing delay). The language is designed for non-computer people. GRASS consists of very simple, straight forward commands which allow the students to work with the Vector General 3DI directly and manipulate the image by means of various dials and buttons.

"GRASS as a language makes it super easy for an educator or student to come in and call up a stored image (a crystal, molecule, etc.) and by means of the language manipulate the image, say rotation by a single dial, programmed in GRASS.

Suppose it is necessary to look at

a particular molecule, a simple sugar for example, which has been named SUGAR. The molecule must be called up from the memory disk, shown on the screen, made larger or smaller and rotated for study. The commands would be typed out on the alpha-numeric keyboard in GRASS:

GET DISK SUGAR

SCALE SUGAR, DO

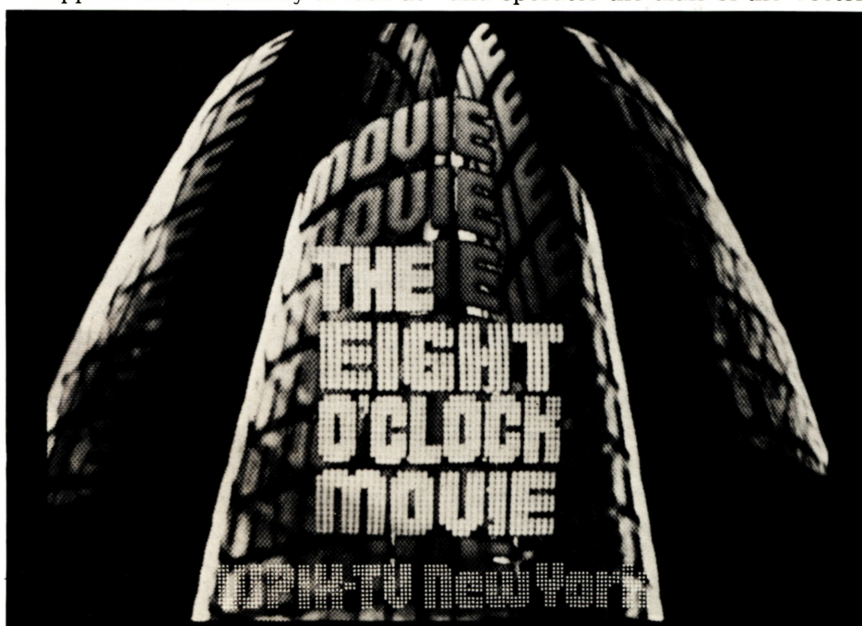
ROTATE SUGAR, X, D1

By means of these three commands the required molecule appears on the screen, its size can be changed by turning dial number "O," and it can be rotated around the x-axis (horizontal) by means of dial number "1."

Sounds easy? It is. And what fun it must be to sit there and play with shapes and movement!

"The display can then be handled by an image processor—colored, mixed and recorded on standard videotape, 3/4 inch cassette or what have you." The system has produced tapes in chemistry, mathematics, medicine and computer programs.

Additionally, since the system operates in real time, it has been used in performance in a live concert. Various monitors were spotted around the concert hall and one large Advent Video projector rigged. There are three performers. One performer programs the computer and operates the dials of the Vector



Dolphin Productions has created a number of TV logos. The Scanimate video synthesizer has an almost unlimited range of manipulations possible with the video image.

PHOTOS: COURTESY DOLPHIN PRODUCTIONS



PHOTO: COURTESY DIGITAL EQUIPMENT CORPORATION

Left: The control center of Dolphin Production's video creations.

Above: Digital's PDP 11/45 introduced in 1972 as a large minicomputer has an internal memory of 262,144 characters and can handle 3.3 million mathematical calculations per second.

General, creating the image. The second manipulates the image processor and colorizes the image and the third performer creates music on an audio synthesizer to complete the video picture. A number of tapes have been made of these concerts and are generally available. PBS has broadcast a number of them.

But is it art? Mr. Cuba maintains that the computer and its peripherals are tools, like brushes and pigments to a painter. That the manipulations of these tools is by the mind of man and just as selectively controlled as any other fine art. "The computer as a tool gives us a new way to explore motion, movement and the kind of imagery that we have never really had the power to explore."

Will we see more computer animation in motion picture making? So far it has had a very limited use. There was a sequence in *UFO: Target Earth* and *Futureworld*. All of the visuals aboard the ships in 2001 were cel animation masquerading as computer graphics. There were some in *Demon Seed*—one of the background display monitors ran a computer-generated model of an earthquake.

Ultimately, there is the possibility that the technology of producing curved surfaces, details, colored and shaded planes will replace some of the rather complicated special effects that can be created only by photography and optical effects.

Already computer controlled cameras could usher in the era of setless cinematography, in which

the actors will work on giant-blue screen sets with all of the details added by computer.

Computer video technology has found its way into commercial television. Numerous commercials and logos have made use of sophisticated video synthesizers to create, without the photographic camera or lengthy cel animation, the images required.

In New York City, Dolphin Productions uses the Scanimate video synthesizer to produce a good many of Madison Avenue's television commercials.

There are only five such machines in the world—originally built by Computer Image Corp. in Denver. The essence of the machine is that you can put down any picture or image and move it, transform it, distort it, flip it, color it right in front of your eyes and record the result on video tape.

The images can be saved, mixed or composited with other images and backgrounds so that little by little a completed sequence can be built up. Much of the credit must go to the enormous advances in recent years of computer controlled video tape editing. With the Scanimate equipment and IVC 9000 video editing equipment a complete thirty second commercial may be produced in eight hours. The going rate, however, is \$8,000 a day and up.

The process starts with an image, either a Kodalith on a light box scanned by a TV camera or a TV studio camera image. The image is then transformed in some manner, for example, compressed into a ball, col-

ored and positioned on the screen.

Then the image can be moved and rolled in any manner around the screen. The Scanimate is operated by patching the video signal through various transforming modules in much the manner as an audio synthesizer. The movements are watched and tested at various settings until the client sees what he likes. Then it is recorded. Eventually a foreground and background reel is generated. At the end of the day the reels are composited, a sound track laid in and the client goes away with a complete TV spot tucked under his arm.

The advantage of the system is that the client can immediately see what he is getting without waiting for various laboratories and optical houses to process films and create effects.

Dolphin's use of the Scanimate equipment allows them to have almost any job out in two days at half the cost of the average commercial. Certainly if the effects of figures twisting, stretching, zooming, strobing, or squeezing against a "three-dimensional" background were attempted with cel animation, the cost would be prohibitive.

The Scanimate, however, isn't intended to compete with cel animation, but to produce visually effective animation on the spot, with the client watching.

Certainly the potentials of computer animation have only been suggested. Much is still unrealized, waiting for the man with the ideas and visions to use these new tools.●

Disney's Calculating Camera

One of the Walt Disney Studios' massive sound stages is beginning to look a little like a NASA control room. It's the same Stage #3 that was built for *20,000 Leagues Under the Sea* in the early 1950s, when the studio began to invest more and more time in live action production. But these days the great tank in the floor is not filled with water or a model of the *Nautilus*. The tank is empty and covered except for a section that allows the lower half of an enormous scenic backdrop to hang below floor level. The backdrop is painted with stars, star clusters and great gossamer fingers of glowing interstellar gas.

Facing this gigantic galactic curtain and mounted on the floor of the stage are shiny twin tubular steel tracks that extend 68 feet to the rear wall of the studio. There, in a glass-enclosed humidity-controlled environment, are the banks of the NOVA 3/12 computer system from Data General. Computer video terminals and display screens can be seen in abundance both within the glass cage and alongside the gleaming metal tracks where a complex series of servo motors and metal arms and platforms rest. A long crane arm extends from the center of the "car" that rides on the tracks. Cables, some two-and-a-half inches in diameter and containing up to 150 pairs of wires, form a

long umbilical cord back to the glass cage.

It could be equipment borrowed from Berkeley's atomic physics lab or a testing bench for a new NASA space probe. But it isn't. It's for fun. It's for making movies. It's ACES.

ACES, or Automatic Camera Effects System, was developed by the Disney imagineers for *The Black Hole*, the studio's first entry into high budget SF production.

Don Iwerks, son of Ub Iwerks, longtime Disney associate, was the project manager for the team that developed ACES. "It was a year ago last January when it became apparent from the script of *The Black Hole* that we were going to have to have some sort of camera system that was capable of precise programming and repeatability."

Repeatability would allow the Disney directors and cameramen to shoot their effects "in the camera." That is, the effects would not have to be shot separately and combined later in the optical printer. A greater sense of reality could be maintained if the different elements of an effects shot could be recorded one at a time in the camera on a single piece of film, instead of assembled later from many pieces of film on the printer. The processing steps on the printer tend to "degrade" the original image and nothing beats the quality of effects



The ACES team assembled for Disney's *The Black Hole*. Seated in front are Director of Miniature Photography Art Cruickshank and Production Designer Peter Ellenshaw. They are seated in front of the very compact operator's console. The ACES camera crane is visible to the far right.



The ACES camera arm tracks a hill-and-dale form to photograph an element for the shuttle-car ride on the *Cygnus*. The camera is rigged with a pitching lens relay system from Continental Camera.

shot "in the camera" on a single piece of film.

"After talking with special effects people Eustace Lycett, Art Cruikshank and Peter Ellenshaw," explains Iwerks, "we were able to determine the design parameters of the system—what the camera would have to do, how far it would have to travel, how accurately, etc." It took about three months, until March of 1978, to complete the specification manual for the system.

David English, systems and electronics engineer on the ACES team, picks up the story. "We spent a good deal of time trying to find out as much as possible about other new camera systems that had been developed. We were hoping to find something that would meet the needs of the company, so that our recommendation would be to just buy it. We knew that we were going to need the system for *The Black Hole* by the first of August and here it was mid-February. It was going to be awfully difficult to get everything up and going by the first of August! Just the computer itself was quoted at four months delivery! We were really hoping that there was something available that would do the job. . . it turned out there wasn't."

"We really had an impossible deadline," agrees Iwerks. "It was in the middle of January that we were talking about the necessity of having the thing, but it wasn't until the first of May that we were actually able to start ordering or building anything. We had the system operational by the latter part of September. It was an enormous project that involved a lot of people's expertise. Amazingly, it all worked out well and came together."

The Automatic Camera Effects System is the first truly computer-operated camera system to be applied to film production. The ACES system calculates camera moves and then sends the appropriate signals to the camera and the servo motor drives to execute those moves. The system has a repeatable positioning accuracy of .01 inch on the dolly and .01 degree in rotation! As far as the Disney engineers are able to determine, no other available camera system has such a degree of accuracy.

What makes the ACES system a

giant step forward in the fast developing field of motion control cameras is the fact that the computer calculates the moves of the camera. How does this differ from, say, the Dykstraflex of *Star Wars* fame? David English explains. "The Dykstraflex system allows you to move a camera through several axis of rotation by manipulating a 'joystick control.' The computer records the moves, one axis at a time. These recorded moves can be played back at various speeds. . . which is great. That movie and its technology laid the groundwork for ACES."

"But ACES," continues Iwerks, "isn't just a matter of recording specific moves." You can tell the computer where you want the camera and the model it is photographing to be at a specific point. The computer calculates the required in-between point, moving the camera smoothly through the take, passing through up to 20 key positions at specified frame numbers. This is done for all 12 axes of motion simultaneously while maintaining auto-follow focus or even automatically positioning the axes to follow a point of interest during the shot! It is this calculating ability of the computer system that makes ACES so powerful a tool.

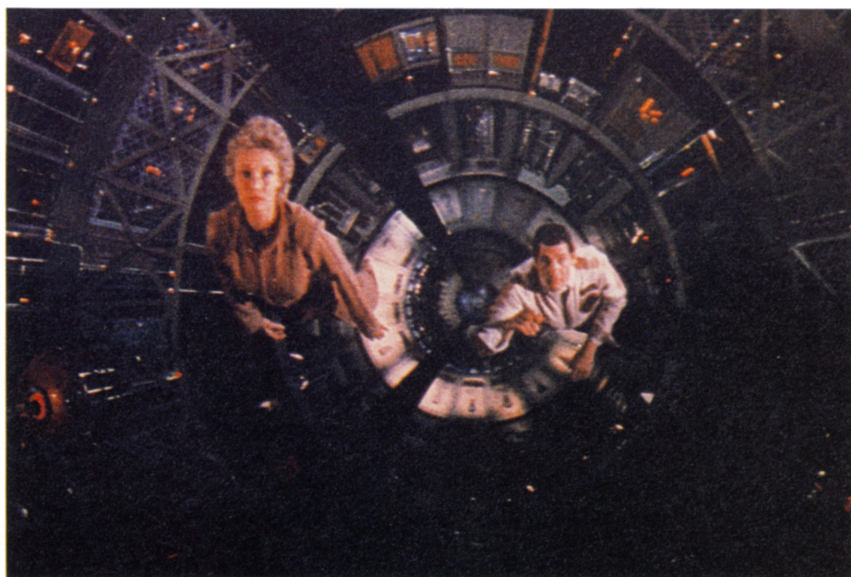
Don Iwerks describes the physical

layout of the equipment. "The camera is mounted on a dolly track that is about 68 feet long. The track is mounted in the cement floor of Stage #3. We excavated the concrete floor in a channel about five or six feet wide. Then we built a new concrete foundation below the level of the stage, so we could put the floor panels back down when we weren't using it and use the stage for other things.

"The track gives us 68 feet of travel forwards and backwards. At one end of the track is a pit—the tank used for *20,000 Leagues Under the Sea*. We can rig a screen or backing down into the pit so the camera can shoot downward. It gives the same effect as having some height to the system. At the opposite end of the track is a storage room built into the sound stage. One half is very much like a garage with a roll-up door. We can back the camera right into it and close the door to store and secure the camera. The other half is the computer room which is climate controlled for temperature, humidity and dust.

"In addition to moving up and down the track, the dolly has its own north-south, east-west axis. There are 48 inches of travel on these axes at a maximum real time speed of six inches per second. The 68-foot track has a travel





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Left: Matte supervisor Harrison Ellenshaw extends the set of the power core of the *Palomino* with a matte painting. The rear-projected plate is the lighter grey area. **Above:** Yvette Mimieux and Robert Forster hang suspended from flying harnesses in front of a blue screen. The finished composite marries a matte painting, a plate of the power core and the live actors, who appear to be floating through the center of the ship. **Top:** The black hole itself and probe ship. Art Cruickshank directed the miniature photography and Eustace Lycett supervised the composite optical work. A.C.E.S. operators: Bill Kilduff and Robert R. Wilson.

speed of three feet per second. All of which are repeatably accurate to within .01 inch.

"The camera itself is mounted on a boom arm. The camera can rotate 360 degrees through the pan and tilt axes, can execute 720 degrees of roll, all at a rate of 36 degrees per second at real-time speed, and is repeatably accurate to within .01 degree of rotation.

"The camera is mounted in a balanced position, but should we need to pan or tilt the camera through the nodal point of the lens (the optical center), the computer will calculate the move for us. We tell the computer where the nodal point is and the computer calculates and executes the pan or tilt through the nodal point automatically.

"The 'point of interest' program is useful, too. We can define a point on the model, say, or just a point in space. We'll tell the camera to do a dolly down the track, do a north-south and an east-west move, a roll and a few other things and the computer has the capability of calculating where the moves should go so we will always look at the point.

"We also have a model track which is an entirely separate piece of equipment. It is identical to the other track physically, but it is portable, and it's about 30 feet long. We can put it anywhere near the camera track. We can set it parallel or crosswise, since the camera track is mounted below the surface of the floor. Once we've

defined where the model is for the computer, it will move both of them in relation to each other and still automatically retain pre-selected points of interest, if we so desire.

"The model stand is rigged with pitch, yaw and roll axes just like the camera stand. There are additional channels in the computer to run ancillary equipment such as lights or special motors on the model which can be controlled and keyed to turn on and off at precise frames. There is a rear-projection screen that is also computer linked.

"The camera is a marvel of construction from Richardson Design. It can shoot standard 4-perforation or 8-perforation VistaVision. It can shoot at 24 frames or a time exposure of any duration at all. It was built under our supervision and with our design. But we are not locked into any one camera. At this time the computer program is set to operate with any one of seven lenses, spherical or anamorphic. The TV monitors automatically unsqueeze the anamorphic image so the operator can see the image unsqueezed in rehearsal."

The video monitor system, one placed at the operator's console and one out at the camera, allows the crew to see exactly what the camera is seeing during the rehearsal of a shot. If the director isn't quite

satisfied with a move within a shot, that move can be altered without disturbing the rest of the shot. The video system is also used to get a 24-frames-per-second replay of a stop-motion sequence. Each frame of exposure is recorded on a video disc instead of tape, since disc has frame-by-frame recording capability and can be played back at regular speed after the frames are recorded. This gives the director a high quality image instantly, rather than having to wait for test film to be developed and printed by the lab.

The system is enormously flexible. Iwerks says, "We have used rear-projection with it. We can run any number of other ancillary devices from the main computer—turn lights on and off, command almost any kind of thing to happen at any point in the photography.

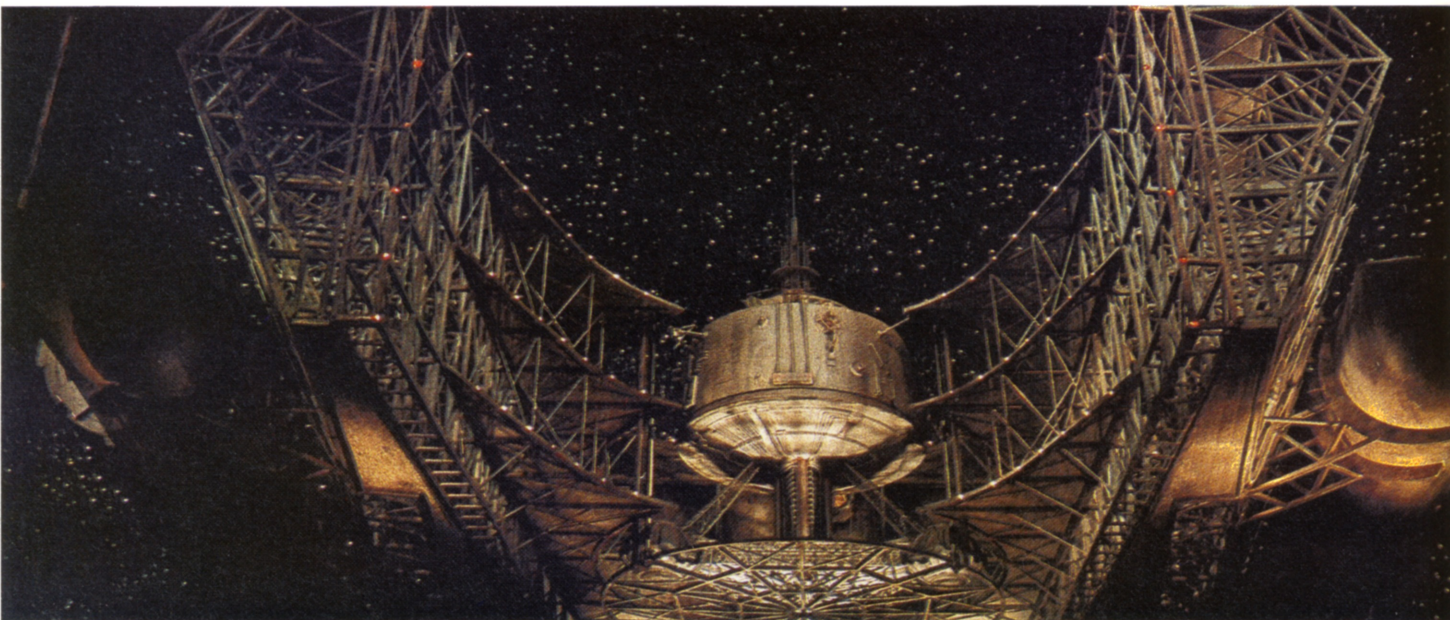
"The computer allows us to be very free. If we don't wish to get the shot all in one day, or if we get started at two in the afternoon and it's going to run to 11 or 12, we can shut the thing down at 6 p.m. by telling the computer to fade out at a certain point. In the morning we can come back up to the point that the fade started and make a cross fade back in again, then keep right on going until we finish that day. You will not be able to tell that the shot wasn't done all at one time.

"Some of our scenes took eight to ten hours to shoot, because we had to use exposures of up to maybe 20 seconds per frame—stopped down to carry the focus. This ability to shut down and pick up the next day was a great convenience.

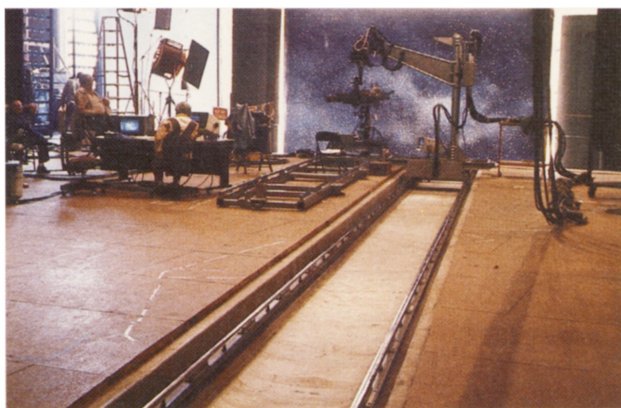
"It is really a marvelous tool to work with—particularly the video system, because a director can plan a shot, program the system in simple terms that a cameraman is used to, rehearse it, look at it on video and make a recording of it. Finally when everybody is happy with the shots and how they cut together, you shoot it.

"All of the information is stored on a floppy disc, so that if at any time in the future you need to do that shot again, all the information is right there—you just load it up and let it run!"

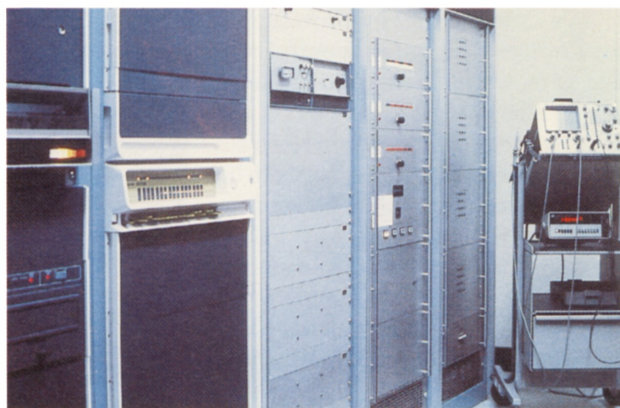
The Disney artists have already been thinking of new uses for the system beyond *The Black Hole*. David English describes how the system was used for Disney's *Watcher In the Woods*. "We take that live action film and transfer it to video tape. Then we take the video signal of the ACES camera and superimpose that ACES model shot and the live action shot on the model through a video switcher. Using test targets we can perfectly line up the registration of the live action and model cameras, so we can



The Automatic Camera Effects System made this complex docking maneuver seem easy. ACES makes feasible effects shots that would either be too costly or time consuming, bringing them within the reach of a production budget.



Top: An ACES-eye view of the *Cygnus* in deep space. The model was photographed by ACES in front of a painted backdrop, so that the star field would not have to be opticaled-in later. The art director wanted the *Cygnus* to appear as a dark shape against a lighter star field, in this case a very dense star field with glowing gasses and nebulae.



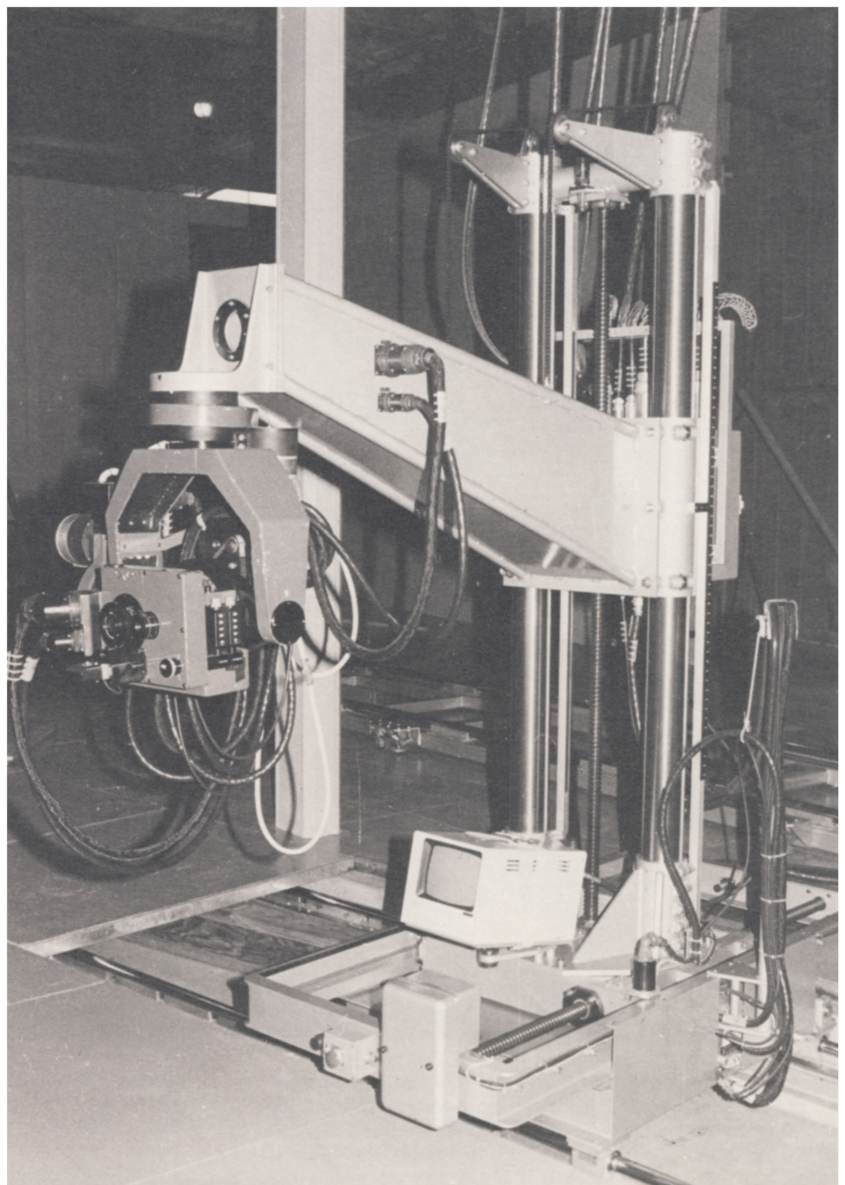
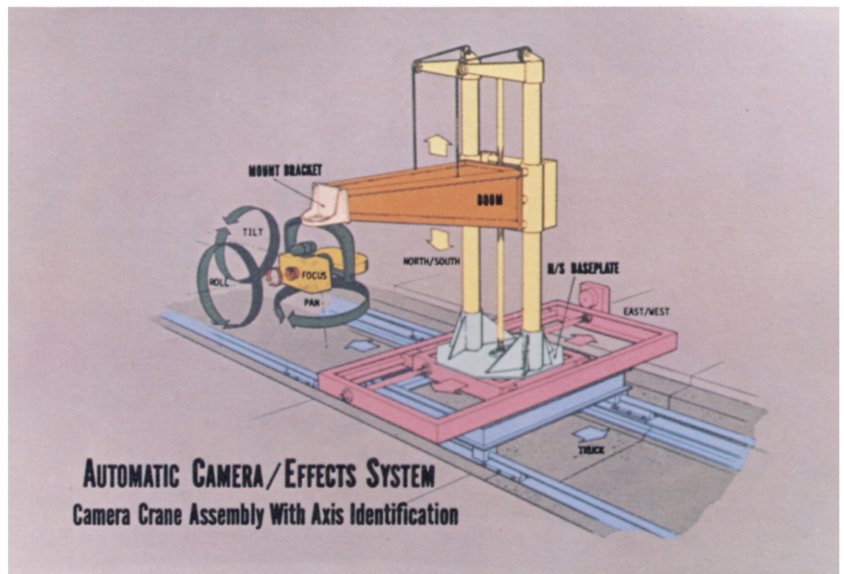
Above left: The ACES camera track and the smaller model track to its left. Note that the camera track is sunk below floor level, allowing the model track to be placed across the camera track. The camera track runs 68' and is fixed in position. The model track is portable and about 30' long. **Above right:** A view of the Nova 3/12 computer and control system.

match our miniature shot exactly to the full scale live action shot!" Thus, even though the live action footage was not shot with any sort of motion control recording device, the ACES system will be able to duplicate the movements of the live action camera in scale for the model. The effects shot and the live action will match perfectly.

"We tried to design the ACES system so that it was flexible enough mechanically, electrically and in terms of the software so that it would allow us not only to meet the initial needs of *The Black Hole* but also be flexible enough to meet the needs that would evolve over the course of time. When the decision was made to do *The Black Hole*, the creative people had a long list of fantastic shots that they wanted. We didn't have the equipment to do it. What we finally built was so far superior to anything else available that, after the equipment was built and they saw what they could do, the demands kept getting more and more complicated. And that's good. That's the role that engineering people fulfill in the Disney organization and the entertainment industry in general."

Speed is one of the most significant aspects of the ACES system. "The video system gives us instant replay and rehearsal capabilities. If we don't like what we see we can edit out any move without affecting the other axes.

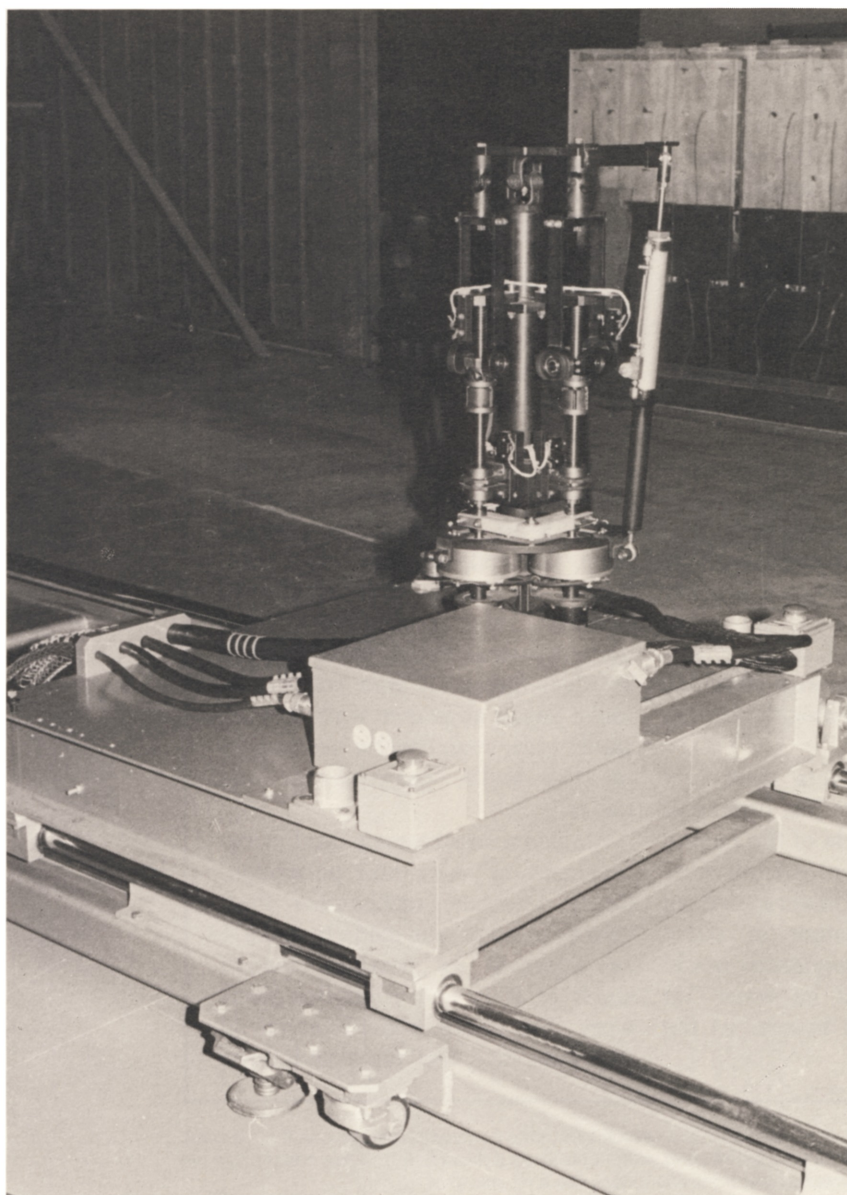
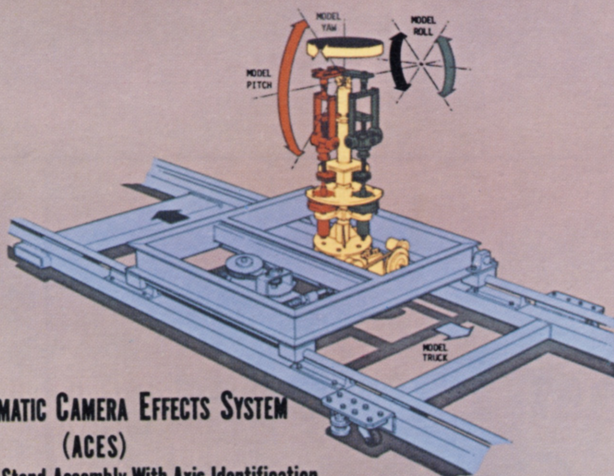
"We create a shot by allowing the cameraman sitting at the control console to move the camera to the position that he wants at the start of the shot. He then selects certain key positions; say at frame 200 he wants to be at one position and at 480 he wants a third and at 1500 he wants a fourth position. At 480 he decides to start a pan or a tilt or the model moving or all three. The computer calculates all of the in-between functions for all of the axes at the same time. It does that very quickly at about 1/10 second per frame, so for a 1500 frame shot it takes about two and a half minutes for the computer to calculate all the moves on all of the axes. Then he just punches a button to start the rehearsal and the system takes the camera and model through all of the axes



The ACES camera crane has great flexibility of motion: note the variety of ways in which the camera can move. The roll axis allows for a full 720 degrees of rotation. Accuracy is .01 degree in rotation.

PHOTOS © 1980 WALT DISNEY PRODUCTIONS

AUTOMATIC CAMERA EFFECTS SYSTEM (ACES) Model Stand Assembly With Axis Identification



The portable model stand assembly has its own axes of movement also controlled by the computer. Any number of ancillary devices can be controlled during a shoot such as rear screen, lights on the model, etc.

as he watches the rehearsal on the TV monitor—seeing just exactly what will appear on film during the take.

“If it so happens that one axis interacts with another so that the path he had in mind is not what it works out to be, he knows it right away—no waiting for test film from the lab. He goes back very quickly and can change the move to correct what is happening. It makes setting up a shot very fast.

“This capability of the computer to automatically compute the in-between positions comes from our long experience with the audio-animatronic creatures.”

The ACES technology may soon expand to other areas in the studio. English explains, “As early as 1971 David Snyder did a proposal to computer automate a cartoon crane, but at that time we were in the process of getting Walt Disney World going. Now we are looking at it again. We hope to expedite the multiple crane. As it is now, it requires a lot of people to operate it, a lot of time to move the equipment in several axes. The ACES system technology is very applicable to that. It could bring the cost of multiple plane animation back to a more realistic level. Now all we have to do is figure out a way for the computer to paint the cels!” laughs English.

“I think with ACES we have given cinematography, direction and production designers a very finely honed tool that can do complicated things very quickly. We hope it will extend the creativity of our artists. It’s like trying to build fine furniture with just a few old chisels and hammers—a fine craftsman can do it, but it will take him a long time and a lot of arduous work. Give that same craftsman some modern tools to work with and he’ll do a better job in much less time. That’s what we hope ACES will provide our people with.

“I’ve been watching the dailies on *The Black Hole* and I really find it difficult to believe that we shot that. I look at the screen and I look at the model and it still looks like Disney hired a mile-long spacecraft and towed it out to the edge of a black hole! That’s what ACES in the hands of the Disney artists can do. It’s exciting to be a part of it.” ●

MAGICAM EXPLORES THE COSMOS

The Public Broadcasting Service has taken Americans on a spell-binding journey through the Universe to explore and explain the manifold wonders of creation. The 13-week series, *Cosmos* was the result of a fortunate coalition of science, business and a special-effects technology called Magicam.

Carl Sagan, that persuasive spokesman for science, enlisted the assistance of various companies to produce the spectacular special-effects sequences that illustrate a number of complex theoretical concepts. Magicam was called upon to produce 90 minutes of special effects to be used at various times during the series.

The Magicam effects team was asked to recreate the lost library of Alexandria, the inside of the human brain, a graphic representation of the life span of the Universe and an imaginary grid system in outer space. All of these sequences would include Sagan as if he were "on location" inside the human, at the library, etc.

Alexandrian Library

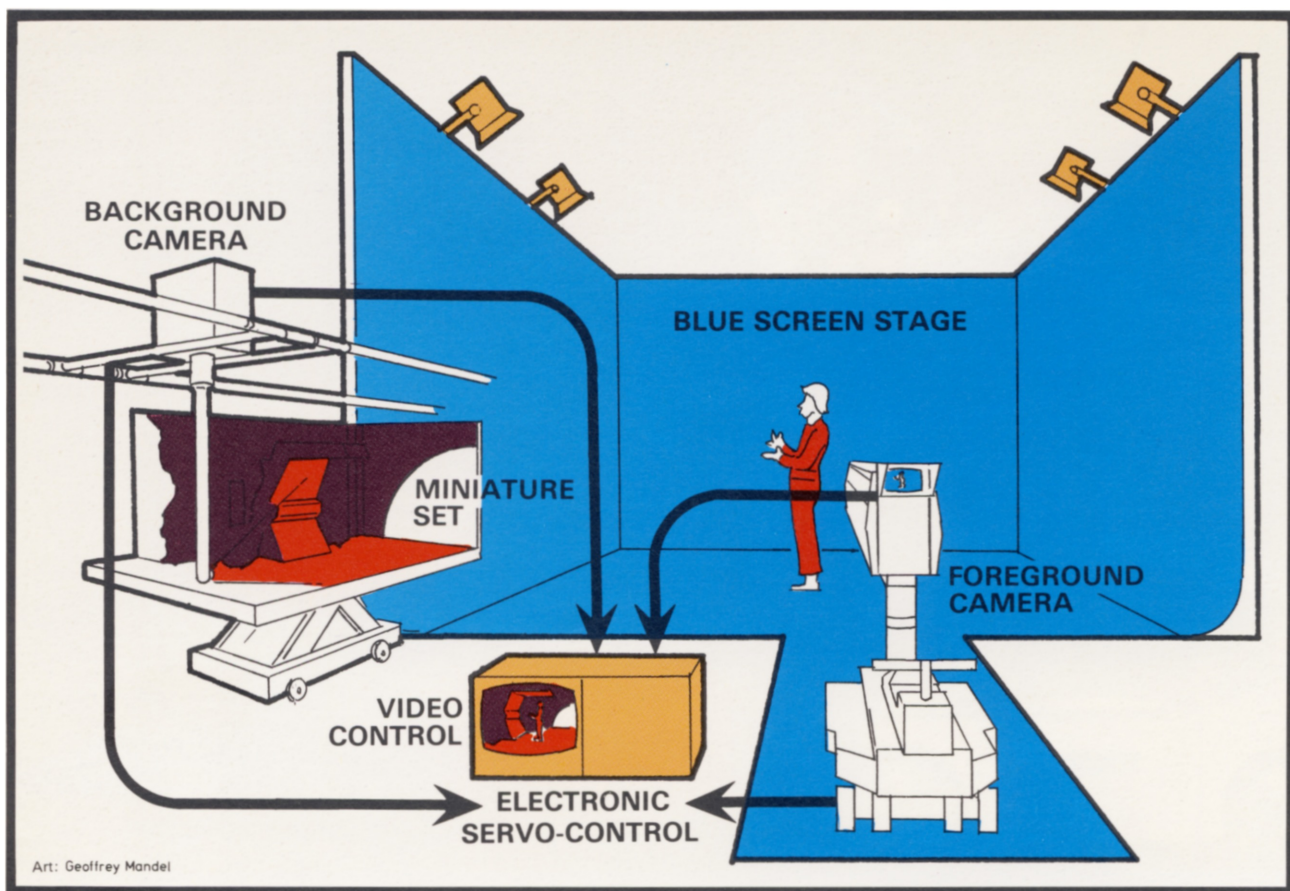
The library of Alexandria was an ancient Egyptian storehouse of all worldly knowledge built by Alexander the Great. When it was destroyed, over a million volumes containing all the knowledge amassed by humanity up to that time were lost.

A model of the library was researched and reconstructed by Jim Dow, head of Magicam's model shop, in collaboration with John Retsek of KCET. With Magicam's process of interlocked video cameras—one on the model and one on Carl Sagan, it was possible to make Sagan appear to walk through the library, even casting his shadow on the walls, passageways and stairs.

Magicam spokesman and vice-president of sales and promotion, Carey Melcher, emphasizes that, "Every attempt was made to make it as accurate as possible, though much of it is just educated guess work. The entire model is about 20 feet long, five feet wide and three

Right: The simple before and after. Magicam is a unique electronic compositing technique that utilizes microprocessors to link cameras on a full size set with cameras on a miniature. The two images can be combined electronically to look like a normal shot.





The above diagram highlights the features of the Magicam system. The background camera (left) reaches into the miniature set with a periscope. In the center is the video control installation which permits the slaving together of the background camera and the foreground camera, shown operating on the blue screen cyclorama stage at right.

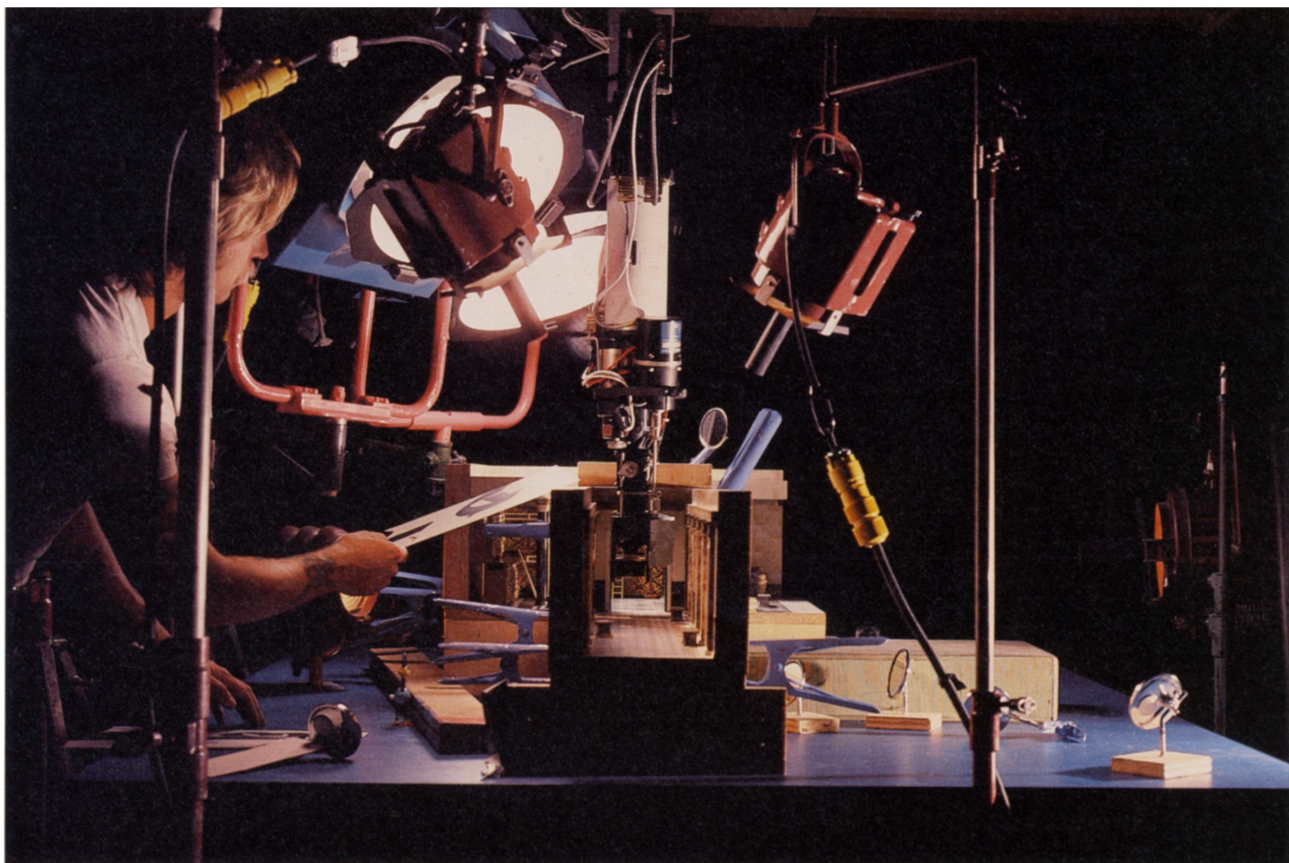
Below: Red suited actors perform on a blue-screen stage before the Magicam camera. The actors will be inserted electronically into the miniature set.



feet high; we had to construct the interior, several rooms and the exterior with formal gardens. It took five months to construct at a cost of \$70,000—which we think is cheap for a model with such extensive detailing.”

Part of the model was based upon the Getty Museum, a Graeco-Roman structure in Malibu. A six-person team using “state-of-the-art” modeling techniques produced the miniature in 24:1 scale. Jim Dow, art director and head of Magicam’s model shop comments on some of the techniques. “The materials we use to construct the models are selected with very specific characteristics. For example, as you know, we have to use quite a bit of light to get the image through the periscope [camera] lens. So the easiest materials for us to work in are plastics, but those plastics have to be selected for their thermal characteristics—that is, the plastics have to at least not melt and at best not flex or change dimension under the tremendous amount of light and therefore heat.

“Most of the plastics used are



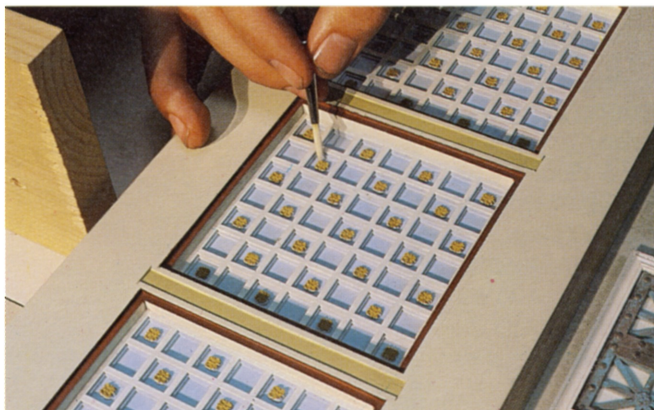
non-expanding epoxy urethanes, which we cast in RTV rubber molds; the original patterns are carved in wax. I've been using these techniques for some time and there are a couple of other shops in town that use those same techniques.

"The marbling of the columns was achieved by marbling the plastic they were cast with," Dow explains. "The natural color of the material was acceptable as a base color. We introduced a white pigment and swirled it for the 'marble' effect. It worked beautifully. The initial column was turned on a lathe and the capitals were carved in wax; a rubber mold was made for the castings. The capitals were all hand painted.

"A lot of the detail in the floor is interesting," Dow continues. "Originally, I was going to paint all that, but we decided to do some experiments, so we went out to the Getty Museum and photographed the rich marble inlays out there. These photographs were then printed by the hundreds. We cut out the photographed tiles and pasted them down to the model." A special adhesive had to be researched that

Above: Periscope camera lens tracks through a miniature set, following the movements in scale of the camera on the live action set.

Right: Jim Dow's model of brain cells, which were inspired by roots from garden vegetables.



Much of the detail on the Alexandrian Library model was hand painted, though Dow did experiment with photographic detailing as well. Marble inlays at the Getty Museum were photographed and printed by the hundreds. The photographed tiles were cut out and pasted onto the model.

would fasten the resin-coated paper down to the plastic model and stand up to the intense heat.

"The murals were all done as full-size paintings, about 16 by 30 inches. These were photographed, reduced in scale and printed on a pebble-finish paper, which gives them a mosaic texture."

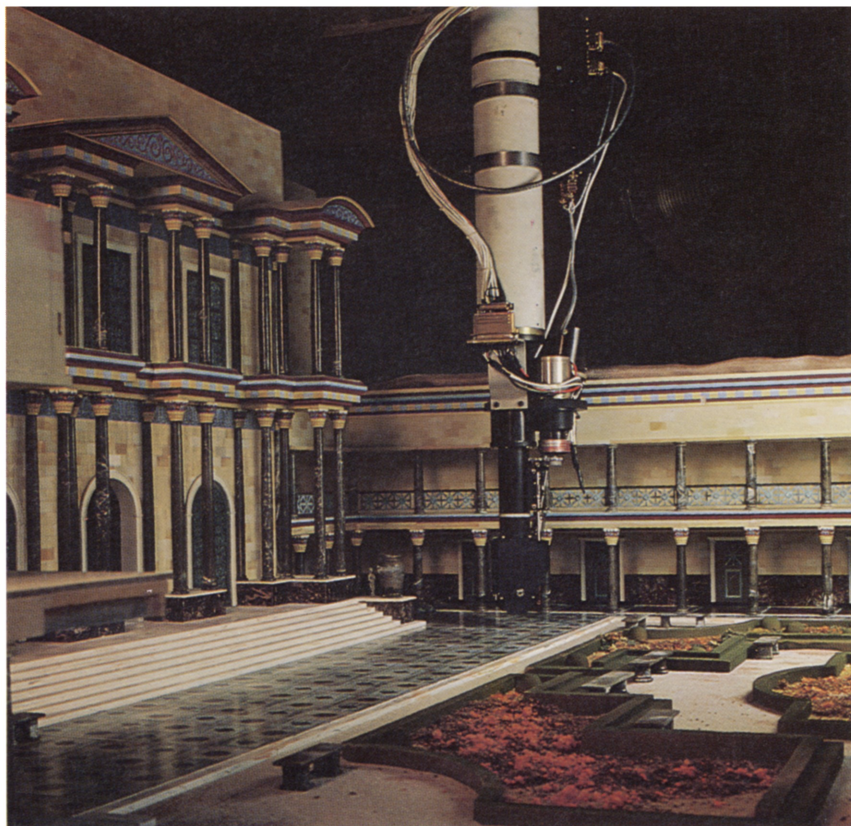
Brain Trip

As Carl Sagan points out, "one of the most significant features of the Magicam process is that it can help us to visualize the world of the small. I would love to use the process to help people understand the microbe world. We could 'shrink' the narrator to the size of an amoeba and have him walk among living cells describing their characteristics."

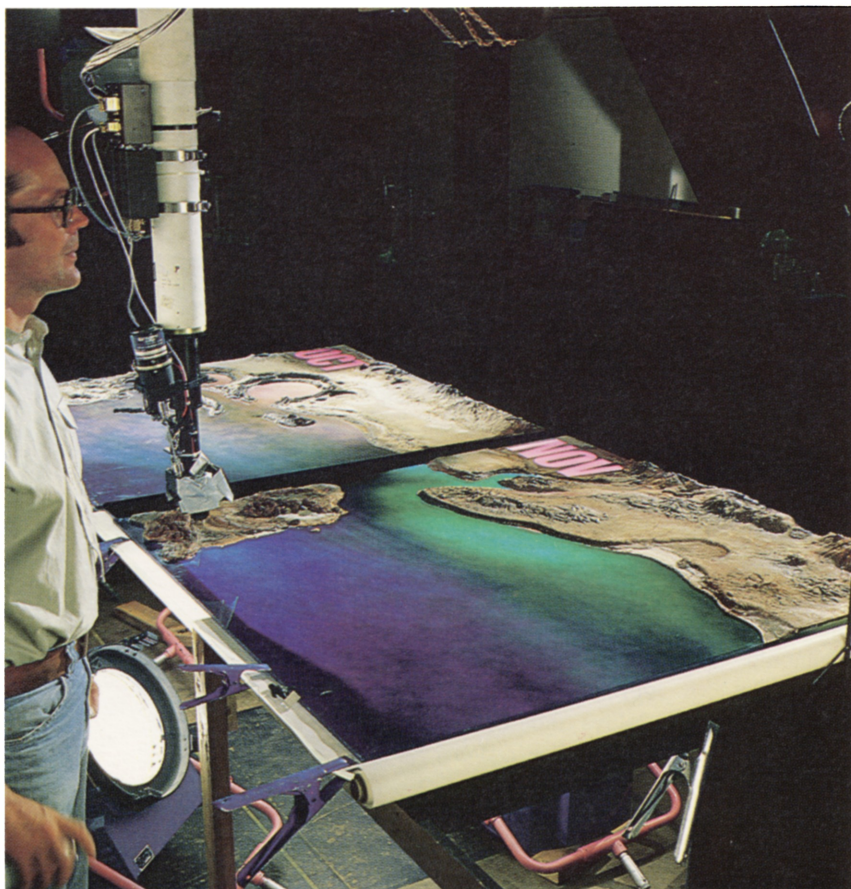
One of the sequences in *Cosmos* takes Sagan into the convolutions of the human brain—another kind of "storage library." For this sequence Magicam had to miniaturize Sagan and magnify the brain tissue. Carey Melcher takes up the story: "We take Carl into the convolutions of the brain and he emerges at the base of the corpus callosum—the dividing canyon between the right and left hemispheres. Then we take him through the wall and down into the neural level.

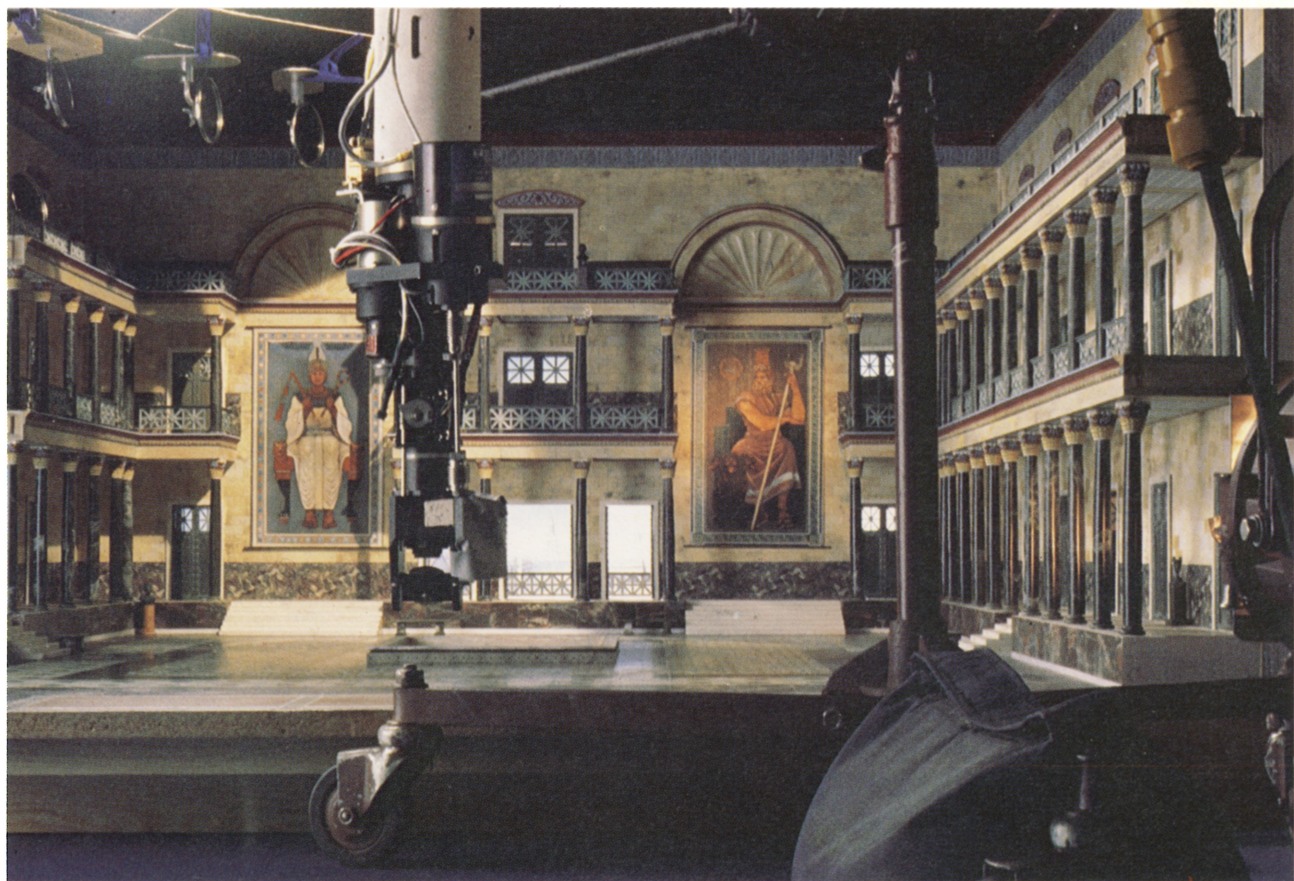
"We sculpted an area of the brain in clay and made a latex mold to produce modules that we assembled into the eight-foot long model of the corpus callosum." The Magicam team studied brain tissue (cat, not human) at UCLA and photographed the microscope neural cells with a scanning electron microscope.

"After viewing the material with Dr. Scheibel at UCLA, I proceeded to construct a model," explains Dow. After several attempts, Dow took castings off of parsley roots and rootabagas and wired them up for models. "The cells really do look like garden vegetables," says Dow with a smile. "The Magicam matting technique allows Carl Sagan to appear to be taking a stroll through the neural network while describing its operation.



Above and next page: Snorkel camera slowly travels through the Alexandrian Library set. Magicam's matting system is sophisticated enough to allow Carl Sagan's shadow to follow the contours of the miniature set—exactly as if he really strolled through the corridors and steps of a full size set. The illusion of reality is uncanny. **Below:** The Magicam miniature of the "cosmic" calendar. For this sequence with Sagan walking through the ages of the universe six generations of video mattes were required.





Space Construction

Another kind of network was created for a sequence which Carey Melcher likes to call "the Shape of Space." Carl Sagan is matted into an animated grid system as he explains the principles and implications of Einstein's Theory of Relativity. The grid system serves to graphically show the flow and curves of the Universe.

"What we really wanted to do," says Dow, "was to define space as grid with computer graphics. But with the restraints of a TV budget, we had to do it with cel animation.

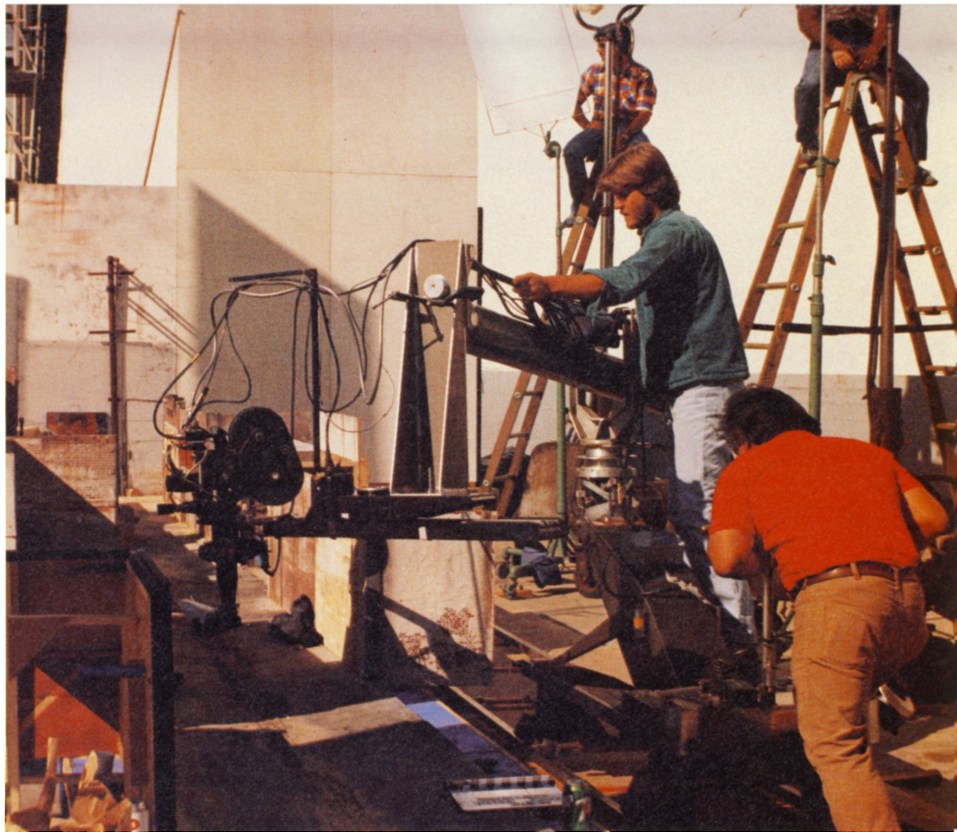
"In 'normal' animation," interrupts Melcher, "you work with 35mm film, but we are working with video tape. We wanted to use the cel animation as a background plate and matte Carl into it. But the 35mm

animated film would have to be transferred to tape. When the film goes through the projector gate, however, there is a slight weave to it. If we matted a solid object like Carl, who is, electronically, a very stable picture, there would be a good deal of 'sawing' between the background and Carl—the elements would weave and jiggle against one another.



PHOTOS COURTESY MAGICAM

"So what we did was to transfer our cels directly to videotape using a color video camera on an Acme animation stand and a digital frame storer. We were able to click off frames of our own animation, store them and relay that directly to video tape; so we had an electronically stable background that we could work with and add whatever effects we desired."



Magicam was hired to create many of the visual effects for ABC's *The Greatest American Hero*. The flying sequences involved an actor in harness on a blue screen stage and the snorkel camera tracking through a miniature alley. Magicam's video matting technique is well suited to the demands of television production.

The Cosmic Calendar

In Sagan's book, *The Dragons of Eden*, the entire development of the Universe is described in terms of a calendar year. It begins at 12:01 of January 1 with the "big bang" and continues to midnight of December 31, which is the present time. The calendar charts the development of

the Universe with whirling galaxies, planetary formation and the like taking most of the "months." In accurate scale all of human history takes up the last "ten seconds" before midnight, December 31.

According to Sagan, "our executive producer initially planned to construct a huge set hundreds of yards long (an enormous strip calen-

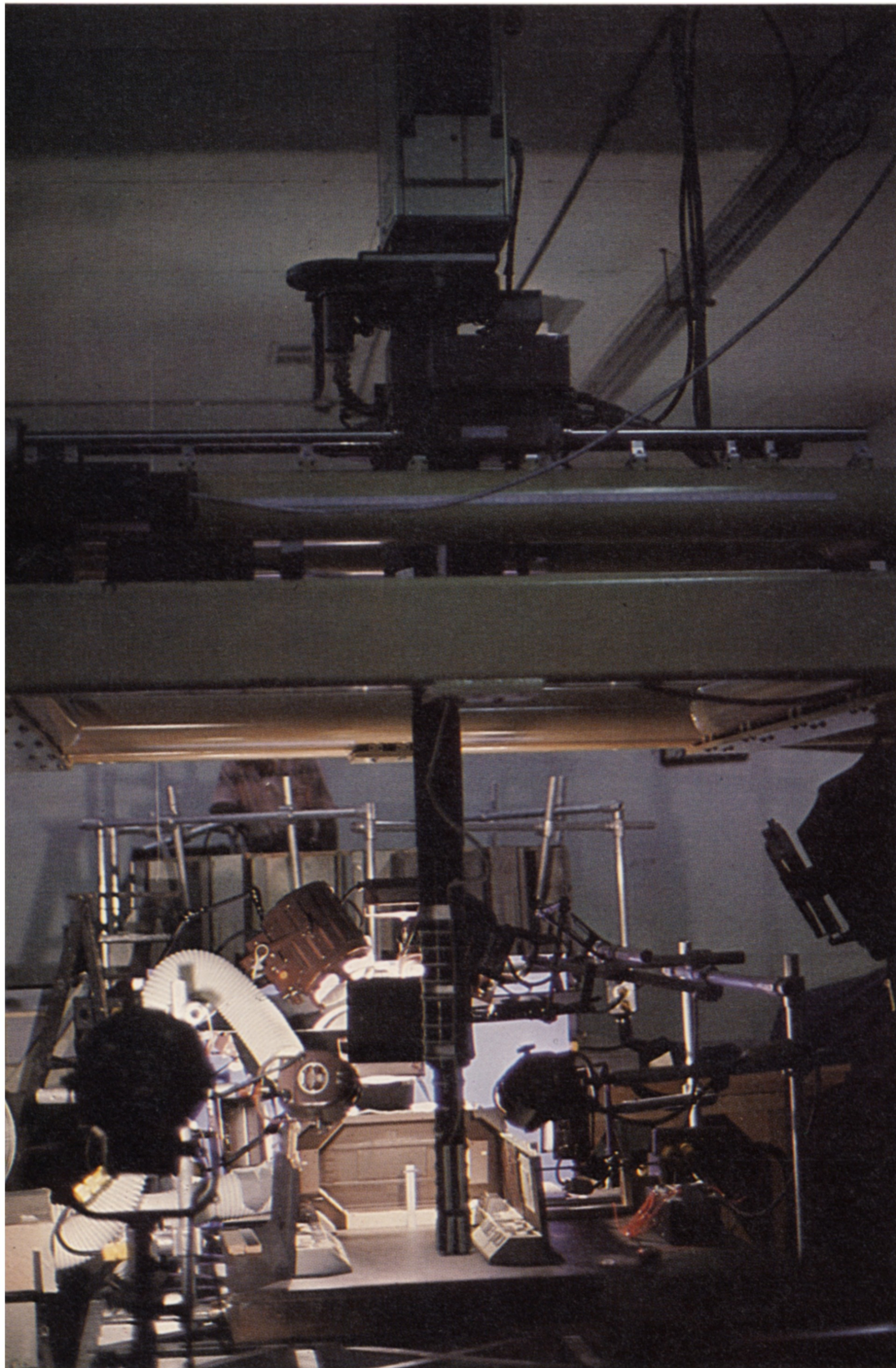
dar) on an old desert air base, but logistics and lighting problems were of enormous concern. But we realized the Magicam process could again be utilized to produce the precision visual effects we needed to present the lifespan of the Universe."

Carey Melcher describes the sequence as created by Magicam: "You are introduced to the calendar through a series of motion-control moves, starting with the big bang, through the formation of stars, galaxies and planets. The camera moves up and around, finally showing Sagan walking through the calendar. We used video motion control to lay in six generations of mat-

tes. Each 'month' had its own special pictorialization—three dimensional planet models, galaxies, etc. The panel's were built out of ½-inch acrylic, airbrushed and underlit, for a spectacular effect... and on a TV budget."

Melcher emphasizes that although Magicam is capable of enormous degrees of sophistication and believability with its process that is not a "one, two, three, bang it out system." It requires ample planning and proper care in pre-production in order to achieve the full value of the system. Properly used, the Magicam process can create extremely complex environments for film and video production at a fraction of the cost these settings would demand were they to be built on a human scale.

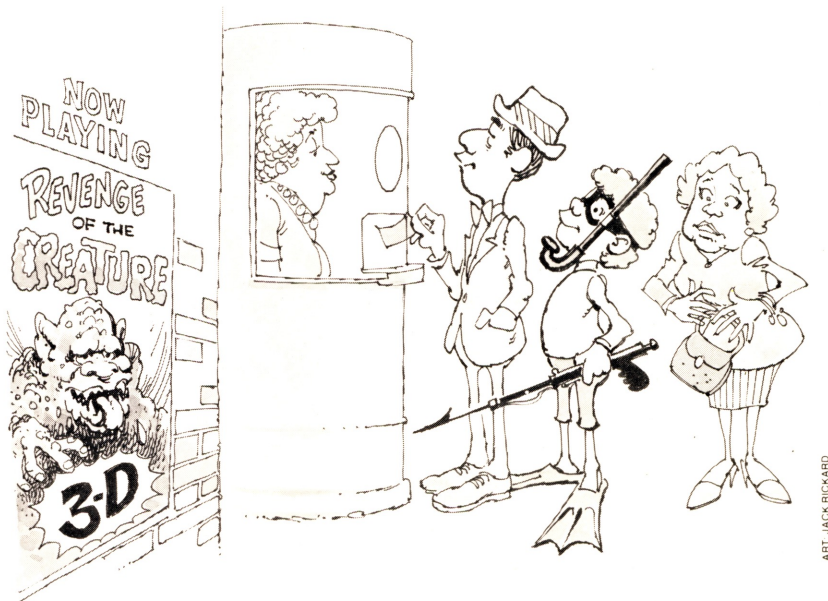
Carl Sagan sums up his experiences with Magicam production: "The science of Magicam is comparable to that used in interplanetary missions, utilizing some of the most sophisticated electronic systems available today. I view it not as an illusionary technique, but as reality machinery that enables people to understand the worlds of the very large and very small. The key element is the motion. It imparts such realism to the film work. I am in the early planning stages of a feature-length film and hope to be able to work with the Magicam crew again, as I was delighted with both the technical and creative support we received from Magicam." ●



A good look at a miniature set on the Magicam table. You can see that the periscope is capable of getting extreme close-ups, requiring that the miniature sets be exactly scaled and minutely detailed.

Quo Vadis 3-D?

Three-dimensional photography is alive and well, both in the movie theater and in the operating room.



Science Fiction writers have made use of the concept of 3-D television and 3-D movies as background props for their stories nearly as long as the genre itself has existed. Furthermore, 3-D technology has been with us since the earliest days of the motion picture. In fact, the first motion picture ever made was in 3-D in 1889 by the English inventor William Friese-Green.

So why aren't we sitting at home watching 3-D TV in color or going to the movies and sitting in theaters ex-

periencing widescreen, surround sound, color . . . and 3-D? Well, it may surprise you to learn that many people can and do.

Movies in 3-D have been exhibited sporadically with varying degrees of success throughout this century—the last big boom occurring during the early 50's. There are still a few theaters today that occasionally exhibit some of the classics (such as *Kiss Me Kate*, *It Came From Outer Space* and *Dial M For Murder*, among others) in 3-D. A few films have been made in 3-D since



PHOTO © 1953 WALT DISNEY PRODUCTIONS

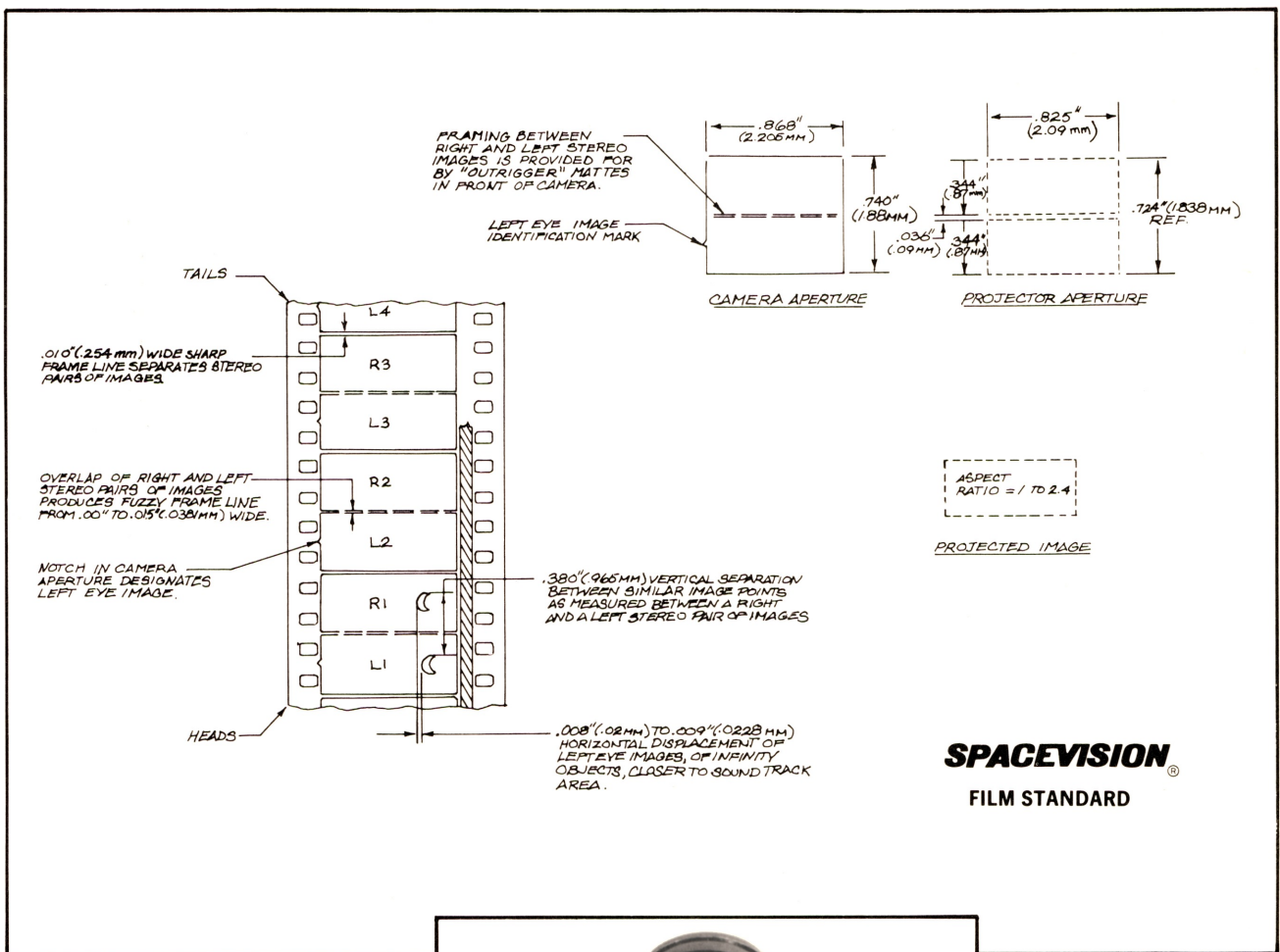


PHOTO © 1953 UNIVERSAL

Above: Disney's "Melody," the first in the series *Adventures In Music*, was animated in Technicolor and 3-D. Directed by C. August Nichols and Ward Kimball with color styling by Eyvind Earle, it was released in 1953. **Left:** Frame blow-up from the anaglyph version of *It Came From Outer Space*. The 2-projector Polaroid version is also still seen. **Below:** Stereotronics 3-D video microscope invented by James Butterfield is used in micro-electronic manufacturing, small parts assembly, biological research and education.



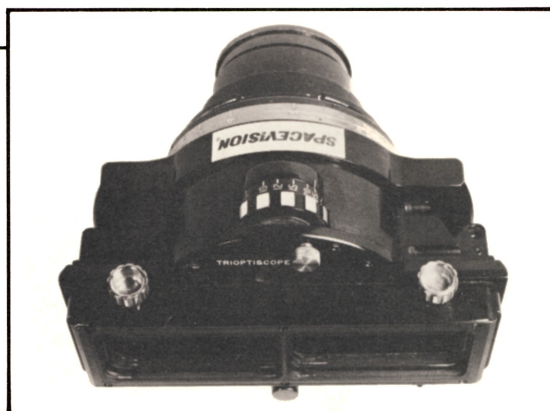
PHOTO COURTESY 3-D TECHNOLOGY CORP



that time for theatrical release, notably *Dynasty*, *Ape*, *Arch Oboler's The Bubble*, *Andy Warhol's Frankenstein* and a few porno flicks. There are also quite a few companies carrying on active research in 3-D movies; companies like StereoMed, Spacevision Stereovision and Dimension-3. United Artists quite recently developed a dual 70mm camera system (surely the Rolls Royce of all movie formats) called StereoSpace and shot test footage in Egypt of the pyramids and Tut's treasures.

But very few of these more recent developments are available for public viewing, with the exception of *Sea Dream*, a very remarkable film created by Murray Lerner, a New York-based documentary filmmaker. Produced in Spacevision (a process owned by E.M.I. Films) for Marineland of Florida, this 23-minute film in color, quadraphonic sound and 3-D has been enchanting visitors since 1978.

Marineland of Florida was created in 1937 as Marine Studios—two large tanks called "oceanariums" were



Above: Technical format specifications for the Spacevision process. Spacevision was pioneered by the late Robert Bernier; the principle of a single-strip over-and-under system is widely imitated. There are other systems today which have greatly improved on this process, but no process is better than the skill and care of the person using it. **Left:** The Spacevision lens.

built to allow commercial filmmakers the opportunity to film ocean denizens in a simulated natural environment. Soon scientists and tourist alike were streaming to the secluded oceanfront site south of St. Augustine to view the unique "windows on the sea." It became the world's first marine life attraction and has enjoyed notable success since its doors were opened to the public in 1938.

Sea Dream, presented in a special 444-seat theater, is part of an ongoing expansion program at Marineland. When Murray Lerner was approached by Marineland to produce a special exhibition film, one of the

possibilities they had in mind was a 3-D film—perhaps because Marineland had been used as one of the locations for the 3-D thriller *Revenge of the Creature* in 1955.

Excited by the possibilities of working in 3-D, Lerner began a year-long search for the 3-D process that would be right for a film with many underwater sequences. "Out of all the processes I saw," asserts Lerner, "I liked Spacevision the best. I found it to be sharper than any other 35mm widescreen process. I did a very elaborate test that took about a month. But as soon as I began seeing footage in 3-D, I knew I had what I wanted and began

to get very excited.

Sea Dream is a nature documentary that makes excellent use of the 3-D process. "When I started scripting *Sea Dream*," Lerner explains, "I tried to analyze the esthetic possibilities of 3-D. I don't think anyone has ever done that with 3-D before. It's usually just added to the story—like taking out black and white film and putting color film into the camera. I knew that *Sea Dream* had to be an 'experience film,' that the medium had to be the message—the fact that I was working in 3-D had to be at the heart of what I was doing."

If the reactions of the audience since 1978 are any indication, Murray Lerner has given them an experience in 3-D filmmaking that is indeed unique. Most 3-D films of the recent past used the screen as a "window"—as if the audience were seated in a darkened room and watching the action of the film unfold through the window of the screen. Occasionally, for shock value, objects would be poked through the window into the audience's faces. Westerns were particularly noted for the sheer quantity of debris "hurled" at the audience. *Sea Dream*, however, gives the viewer a new experience. Lerner attempts to fill the space between the viewer and the screen. The film's

dramatic impact is heightened considerably with so much of the action appearing to take place within an arm's reach of the viewer. Lerner enjoys playing with the audience; right at the beginning of the film, he establishes the exciting potential of 3-D to his audience by having a frisbee come sailing over the waves, off the screen and remain floating just a couple of feet in front of the viewer's nose. It's startling and exciting and it lets the audience realize what they are in for when the frisbee dissolves into the image of a sea creature—the audience finds itself looking not through a window at the world, but experiencing the world projected into their midst.

Lerner comments, "I found that most oldtimers in 3-D films like to place the action 'beyond the window.' I guess they were afraid to shock the audience. It's just like the early days of regular cinematography when the cameramen were afraid of wide angle and telephoto lenses—they stuck to the so-called "normal" lenses. They all insisted on a lens that resembled the way the human eye worked and anything else was wrong. But this is an esthetic consideration. They didn't understand the drama of the medium. Film isn't vision. Film shouldn't seek to recreate normal human vision, because film is better

than that. You are limiting yourself dramatically and artistically."

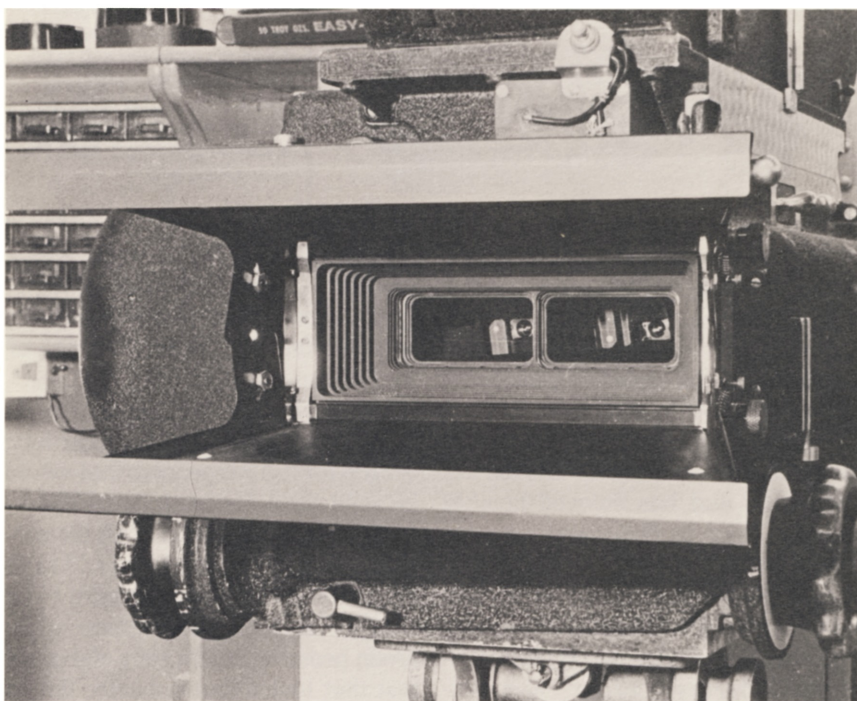
Spacevision's inventor, the late Bob Bernier, was aware that there were many technical considerations and limitations to 3-D films. Many systems in the '50s were restricted to shots that closely matched the capabilities of human vision. Spacevision seems to be good at producing unusual shots without eyestrain.

Spacevision's 3-D lens is simple to operate. The system utilizes a single 35mm camera with the Spacevision Trioptiscope lens which "sees" two viewpoints on a horizontal plane similar to one's eyes. These two images corresponding to the right and left eye view are stacked on top of the other within the standard 35mm frame. This slitting of the 35mm frame gives Spacevision its widescreen aspect ratio of 2.35:1.

Lerner is looking forward to continuing his work in the 3-D medium. Quite a number of SF film producers and directors have seen special screenings of *Sea Dream*, which Spacevision now uses to show off its process. Even Dr. Land of the Polaroid Corp., and one of the pioneers in 3-D system development, has said that *Sea Dream* incorporates some of the finest 3-D photography he has ever seen. Lerner thinks that science fiction, fantasy, horror, magic and the circus are all ideal for the medium of 3-D. But Lerner maintains that whatever the genre, it should be scripted for 3-D so that it becomes a "total experience." "You have to think of the medium," Lerner maintains. "I think talking heads would be the weakest possible subject matter for 3-D. You have to pick your story for the medium."

A 3-D film is a very different experience. In ordinary "flat" films, when the camera goes to close-up, the image gets bigger on the screen. Sometimes it can be quite disconcerting. There were some Cinerama close-ups of faces that created Broddingnagian nostrils that you could have driven a truck through. But in 3-D, a close-up means that the image comes closer to you. It stays the same size, but comes right up to you—face to face.

Sea Dream is such an accomplishment in 3-D technology that the



Spacevision's Trioptiscope lens mounted on an otherwise unmodified 35mm motion picture camera. The "outrigger mattes" in front of the lens provide framing between right and left stereo images.



PHOTO COURTESY MURRAY LERNER

Above: Marineland audiences experience the 3-D thrills of "being" underwater. The picture on the screen is simulated for this illustration. **Left:** The Spacevision camera in an underwater housing filming sequences for *Sea Dream*.

Museum of Holography in New York City arranged for Saturday screenings as part of their exhibit—"Similar Visions" in 1980. The infant art and science of holography is no match for modern processes like Spacevision. The technology of stereoscopic photography dates well back into the last century while holography is only two decades old.

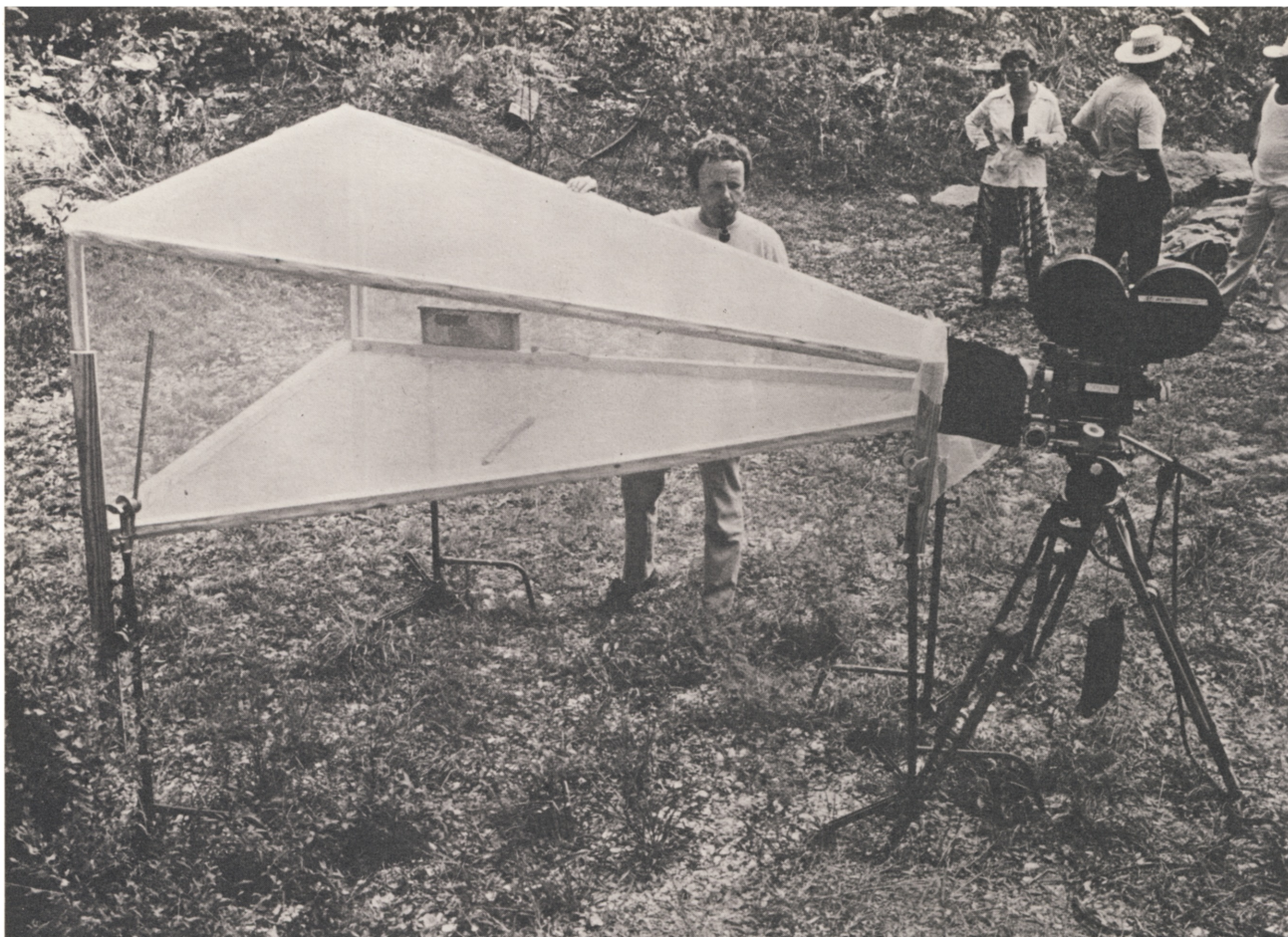
But what about that 3-D TV broadcast mentioned in the opening of this

article? Well, 3-D TV does indeed exist today, though it is not nearly as accessible to the general public as 3-D movies. There have been public demonstrations though, and 3-D TV is used in closed circuit systems in nuclear power plants, hospitals and scientific research laboratories. From time to time, demonstrations of state-of-the-art 3-D TV are held at technical conferences and conventions. As long ago as 1972, John

Rupkalvis of StereoMed presented a large screen (6 x 9 feet) demonstration of live closed-circuit, three-dimensional color TV for the Architectural School of the University of Minnesota. Nearly a decade earlier in 1954 and 1955, James Butterfield (who currently holds a number of patents in 3-D TV) transmitted 3-D TV on a daily basis in Mexico.

One of the most remarkable applications of 3-D technology has been in the field of microsurgery. Dr. John P. Beale, Jr. of the San Francisco Eye Institute, a pioneer in the field of microsurgery, saw the need for a new medical instrument which would combine a surgical optical microscope with color 3-D television—a Surgical Stereo-Video Microscope. Dr. Beale went to James Butterfield with his request and such a system was developed.

In June of 1974 a patent was granted to Mr. Butterfield for his Stereo Television Microscope



Spacevision system is set-up to film butterflies. The special net-covered frame keeps the butterflies in front of the camera.

(#3,818,125). The system incorporates a miniature 3-D color television camera attached by means of a beam splitter to Dr. Beale's surgical microscope. During the operation the surgeon is able to use either the optical microscope or view the 3-D television screen without any special glasses. The surgeon is no longer tied down to a single tiring position during the long hours of surgery. He is free to move his head, look at his assistants or other instruments without having to refocus his eyes as would be the case with a conventional microscope.

Dr. Beale also employs the use of a large monitor in his operating room so that the operating team can view the progress of the operation. The signal can also be fed out to other color 3-D TV monitors so that visiting doctors and personnel can observe the same picture the surgeon sees and follow his progress during the operation.

The 3-D picture can also be videotaped for "instant-replay" in the operating room, should the surgeon so require, or to allow students the

opportunity of witnessing the operation in the classroom at a later date. Doctors have found such 3-D color videotape presentations to be extremely helpful in the classroom. Many times, during the heat of an operation, a surgeon will make decisions about a choice of procedure and hours, days or weeks later may not be able to recall the precise circumstances that required that decision at that time. With the operation recorded in all the depth of 3-D color TV, the circumstances can be replayed for himself and the class. As a bonus, since the entire operation has been recorded on videotape, insurance companies may be more inclined to lower their malpractice premiums, since direct evidence is available to them should a case have to go to court.

Dr. Beale has performed numerous operations using the 3-D television image. The 3-D color image has given him the assurance and confidence to perform very delicate sewing, cutting and other procedures on the human eye in which depth perception is an

absolute necessity. The inventor and patent holder, James Butterfield, reports that Dr. Beale has used the equipment to perform such procedures as the Strabismus (crossed eyes) operation, corneal transplants and cataract and cornea procedures. The high resolution image (1,023 scan lines as opposed to the 525 lines for home broadcast), the precision color control possible and the all-important stereo depth of the image have given Dr. Beale a unique and valuable tool.

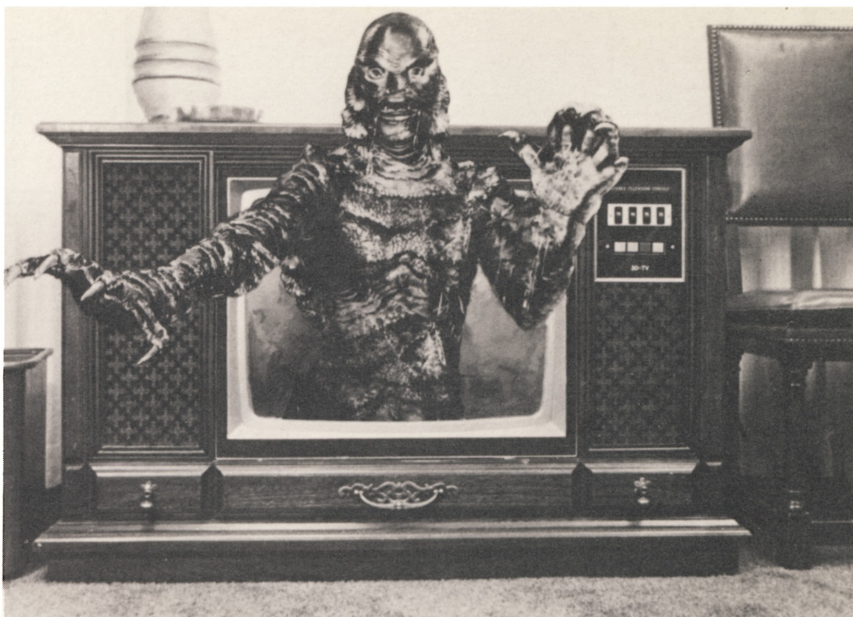
Recently, Mr. Butterfield has been developing a Stereo Video Microscope for industrial applications. An obvious application is assembly line examination of micro-miniature integrated circuits which may have more than 30,000 elements in a chip only 1/4-inch square. In addition to seeing a high resolution 3-D color TV image magnified a thousand times, a flick of a switch enables the viewer to reverse the image from a positive to negative or to any number of "false-color" displays that often reveal details not normally visible.

The 3-D TV camera can be made sensitive to infrared or ultraviolet light or even to X-rays, so that human eyes can see on the 3-D TV screen objects illuminated by "light" outside the range of human vision. Mr. Butterfield says that his Stereo Video Microscope "takes viewers on a voyage into micro-space in the same way that a spaceship might travel through outer space."

NASA has made use of Mr. Butterfield's 3-D TV to view 3-D pictures taken by Earth satellites. At the Goddard Space Flight Center in Greenbelt, Maryland you can look in 3-D down through the eye of a hurricane with stereo pictures taken by one of the weather satellites.

Back on Earth, Mr. Butterfield is building a 3-D TV system for Lawrence Livermore Laboratories. The 3-D TV cameras are the eyes of a WORM—a robot-like device that can see in almost total darkness to explore areas of nuclear reactors too dangerous for human personnel. With the aid of the 3-D TV monitor "eyes," human controllers can check for radiation leaks and manipulate tools and equipment with the accuracy of full depth perception.

But what about 3-D TV at home? Well, there are quite a few systems being developed in the U.S. and abroad. In Australia the DOTS system attempts to make 3-D compatible with normal color broadcast: Viewers with special glasses will see a 3-D TV picture, but viewers without glasses will see a normal color image. The process has been criticized for the very low quality of the 3-D image created. In the United States there are both no-glasses and glasses-required systems. James Butterfield, again, has built a fully operational 3-D TV (the prototype is in black and white) that does not require the



The creature terrorizes Alaska viewers during recent 3D TV transmissions via 3D Video corp. process.

viewer to wear glasses of any kind. Russian technicians have been researching no-glasses 3-D since the early 1940's, but Dr. Victor Komar, one of the U.S.S.R.'s leaders in 3-D research and development, recently viewed a demonstration of Mr. Butterfield's 3-D TV without glasses and came away impressed.

Mr. Butterfield's company, The 3-D Video Corp., developed the system currently being used by SelecTV, VISIONS and MultiVisions to transmit classic 3-D motion pictures to home viewers. Mr. Butterfield reports that he has taken the old anaglyph system to its ultimate development by allowing color films to use the anaglyph system. It should be noted that these broadcasts are true stereoscopic 3-D transmissions as opposed to a system that has been used for children's programming in Japan based on the old Pulfrich illusion. Mr. Butterfield's system allows objects to come out of the screen to within a few inches of the viewer's eyes and go back some distance into the screen.

Because of the increasing activity in 3-D research many people have suggested that 3-D is finally "just around the corner." Cable-TV subscribers have been the first home-viewers in the U.S. to see test 3-D transmissions in this decade. The big stumbling block is the F.C.C.'s insistence on compatibility with current broadcast standards, but a re-

cent Geneva conference may sweep all that aside. But even within the F.C.C. there is no question in anyone's mind that the world *will* have 3-D and that, in the future, it will become just as standard as color TV is today.

If you think that your business or industry could profit by the application of 3-D technology, one or more of the following companies may be of interest to you:

3-D Video Corp.
James F. Butterfield,
Technical Director
10999 Riverside Drive
Suite 208
N. Hollywood, CA 91602

StereoMed
John Rupkalvis
8208 40th Avenue North
Minneapolis, MN 55427

Dimension-3
Daniel L. Symmes
256 South Robertson Blvd.
Beverly Hills, CA 90211

Spacevision, Inc.
EMI Films, Inc.
9489 Dayton Way
Beverly Hills, CA 90210

Stereovision, Inc.
Chris Condon
3421 West Burbank Blvd.
Burbank, CA 91505



John Rupkalvis' custom stereo camera.

ALLDER AND JOHNSON: SPECIAL FX SUPERVISORS

Brian Johnson and Nick Alder share the screen credit and responsibilities of "Special Effects Supervisor" on 20th Century-Fox's release, *ALIEN*. The association between the two is not a new one, as Alder remembers. "I suppose Brian and I have known each other for 10 or 15 years, possibly," Johnson concurs. "We've worked on a lot of pictures together. Nicky is working with me now on *The Empire Strikes Back*."

In effect, the partnership of Johnson and Alder enabled *ALIEN*'s "Special Effects Supervisor" to be in two places at the same time. Alder elaborates: "While I was with the main unit supervising the shooting at Shepperton Studios [where the live-action, full-scale photography was done], Brian was at Bray [Studios] keeping an eye on the models—getting them built and shooting the tests."

Before the filming of *ALIEN* began, Johnson had already agreed to do the *Star Wars* sequel, but because of his long association with Alder, Johnson felt perfectly confident leaving Alder in charge. Says Johnson, "I directed all of the effects for *ALIEN* until I left to join *The Empire Strikes Back*. Then Nicky took over."

"I was presented with the script to *ALIEN* a long time ago," remembers Johnson. "I was working for Gerry Anderson on *Space: 1999*. Walter Hill, Gordon Carroll and another *ALIEN* director called me in to discuss the script. At that time there were very few special effects in the script—one or two establishing shots in space and some floor effects."

"After some discussion, they asked me to do the movie, but the film was going to be in preparation for some time and lots of things were going to be changed, so I went to work on *Revenge of the Pink Panther*, *Medusa Touch* and one or two other things."

"Then one day I got a call from 20th Century-Fox asking me to do the effects on *ALIEN*. At that time I was just about to start the *Star Wars* sequel, but I said, 'Great! I'd love to do it.' I had a meeting with Ridley Scott, who is a wonderful storyboard artist. We looked over his drawings and set a tentative date. The understanding was that there weren't going to be so many effects that I couldn't still carry on with *The Empire Strikes Back*."

Although *Empire* and *ALIEN* are both Fox pictures, Johnson had signed with *Empire* first, so Fox had to get permission from George Lucas and



ALIEN proved to be a fascinating challenge for effects supervisors Johnson and Alder.

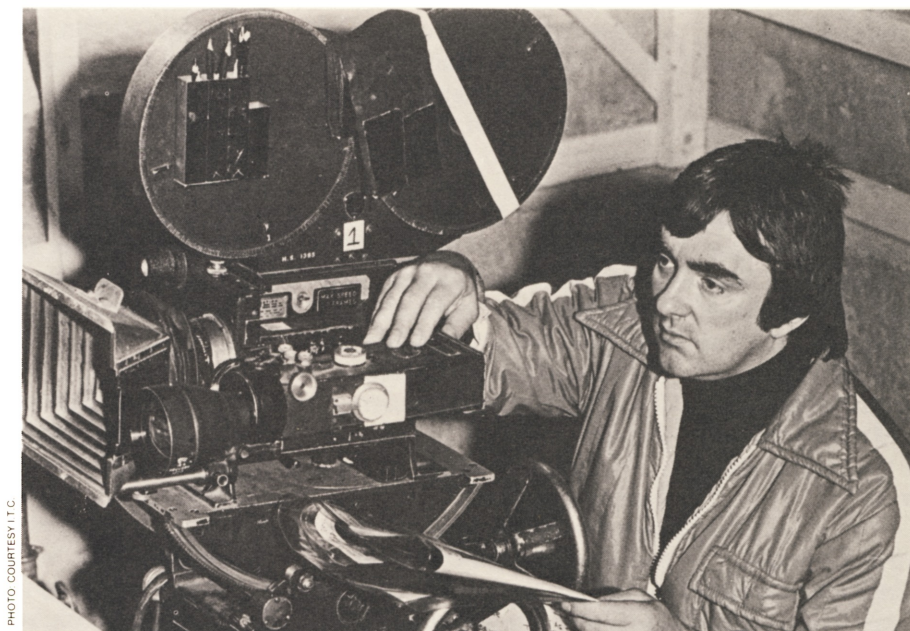


PHOTO COURTESY I.T.C.

It was while Johnson was still working on Gerry Anderson's *Space: 1999* that he was first presented with the script for *ALIEN*. Johnson is seen here behind a high speed Mitchell 35mm camera preparing to shoot a sequence in miniature for *Space: 1999*.

Gary Kurtz to allow Johnson to do both pictures. "Actually, George's company owns *Empire*, while *ALIEN* is totally financed by Fox," Johnson explains.

"It was never my intention not to give each picture 100 percent of my time. Though we did manage it, I can tell you that it has been a big strain on all the SFX crews concerned with shooting both *ALIEN* and *Empire*. People develop split personalities when working on two pictures at once—their loyalties get divided. It's very difficult to give a picture your full time and effort when you know there's another which requires your time and effort, too. We worked very long hours on *ALIEN* and everybody got very tired. That's not the best way to start a major movie like *Empire*."

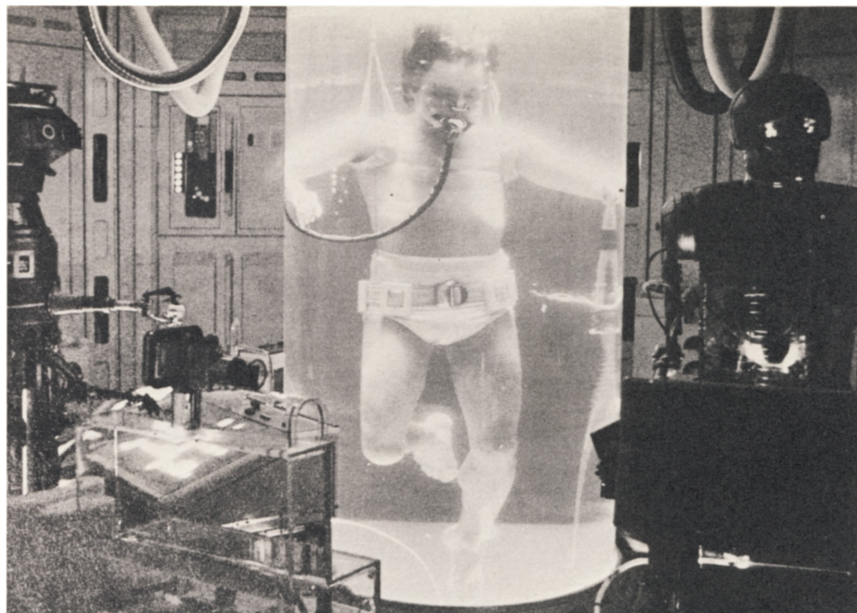
"We've had some pretty rugged locations on *Empire*. We've been to Norway, where it was 50° below zero. We are working full-out, but we are all going to be very glad to finish the picture and have a rest next year. I haven't had a vacation in five years."

Brian Johnson rose to prominence in the U.S. when his work in Gerry Anderson's *Space: 1999* TV series attracted so much attention. His work for this series and most of the photographic effects work in *ALIEN* took place at the specially equipped studios at Bray, near Windsor, England, where many of the Hammer horror films were made.

On *Space: 1999*, Johnson is credited as special-effects designer and supervisor. On *ALIEN*, as supervisor, Johnson "designed the way the effects were to be done. I determined the size of the models," says Johnson, "and their manner of construction. I selected the crew and drew up the budget. I decided how the various shots were going to be done."

A Lucky Career Change

Born in Surrey, England, Johnson's ambition was to take up flying as a career, but he was advised against it on medical grounds. Instead, he got a job with a company specializing in the making of television commercials and after a time found himself promoted to the laboratory. The next three and a half years were spent working with cameras on a variety of film documen-



Johnson had to leave the set of *ALIEN* early to work on *Empire*, Nick Alder took over for him on *ALIEN*. Mark Hamill, above, recovers from an encounter with a snow creature.

PHOTOS: 1980 LUCASFILM LTD.

taries and TV commercials, and then as an assistant on feature films.

Johnson's budding career was then interrupted by the National Service, where he performed various duties in RAF Transport Command. Shortly after returning to civilian life he found himself working on visual-effects camerawork, a field in which he has specialized ever since.

Over the years Johnson has been responsible for many of the eye-boggling events seen in such movies as *Taste the Blood of Dracula*, *When Dinosaurs Ruled the Earth*, *2001: A Space Odyssey*, *Revenge of the Pink Panther*, *The Medusa Touch*, *Mosquito Squadron*, *Nothing But the Night*, *The Blockhouse* and *The Tamarind Seed*. His effects magic has also been featured on television on *The Protectors*, *New Scotland Yard*, *Day After Tomorrow*, *Stingray*, *Thunderbirds* and, of course, *Space: 1999*.

On *Space: 1999* his jobs included designing the models, painting original artwork, working on floor effects and directing the combined skills of his hand-picked, and highly efficient, 12-man effects and camera crew.

Nick Alder was born into the film industry. His father, the late John Alder, was a camera engineer. The younger Alder began his career as an assistant rostrum cameraman with a film company making commercials. Eight years later, he switched to camera special effects. He joined the

late Les Bowie's special-effects company in the early 1960s where he worked on several Hammer films.

Alder spent 11 months in Egypt working on the epic *Khartoum*, then the Academy Award-winning *A Man for All Seasons*; after this he was off to Malta for a thriller, *Twist of Sand*, then two years on the aerial process photography for the mammoth *The Battle of Britain*. From working in the air, he went underwater for photography on *Submarine X-1* and the underwater tank sequences on the Alistair Maclean thriller *Fear is the Key*. His other films have included *The Long Duel*, *The Medusa Touch*, *The Wild Geese*, *The Revenge of the Pink Panther* and three years as special-effects cameraman on *Space: 1999*.

They Came Prepared

The varied backgrounds of Alder and Johnson prepared them ideally for the problems they encountered on *ALIEN*. Johnson remembers, "One of the difficulties with *ALIEN* was the way the project grew. With [director] Ridley Scott you've got a man who keeps adding things and changing things. One has to be on top of the situation and say, 'Well, no, you can't do that at the moment, but give us a few days, a few hours and you will be able to do it.'"

"We went through quite a number of evolutionary processes—equip-

ment was modified or thrown out altogether as new ideas were generated. Usually the new equipment would be totally different from the original device. Eventually, we got what we hoped would be convincing on film."

Johnson and Allder found Scott's penchant for last-minute improvisation to be both a challenge and a joy. "This is why making motion pictures (even the most commercial) is still an art form," Johnson believes. "You still have the joy of experimenting and discovering new things; whether it's a new chemical that gives you a weird texture to photograph, or just spending an afternoon dropping different substances on glass and photographing them. You look at everything in life from the point of view of what it would look like on the movie screen if you tried to photograph it."

I visited Bray Studios in October of 1978. There, Nick Allder, at work on *ALIEN*, was kind enough to show us the *Nostromo* and its cathedral-like "processing refinery" in tow.

"The complete model," said Allder, "is about 18 feet long and weighs about 800 lbs. The detailing of the models is particularly rich, much of it manufactured and turned out on a lathe. From whatever angle and however close you wish to work the camera, the sense of scale and detail never diminishes."

Three models of various scales were built of the *Nostromo*. The ship's jets are rigged with high-intensity quartz lights and plumbing for the vapor jet. Allder explained. "We started using freon on *Space: 1999* for rocket exhaust in space. Thank goodness we've left behind the pyrotech-

nic exhausts like we used in *Thunderbirds*. On this kind of work it would look very silly, and completely incorrect. The plumbing we have installed in the tail of the model for the exhaust jet is very sophisticated—it is electrically operated by remote control so that at the touch of a button the jet will switch on or off."

The model of the *Nostromo* is surrounded by a black cyclorama. "Our camera system incorporates a very sophisticated grid system so we can actually do multiple exposures. This technique, which records only on the original negative, will give us much better quality than traveling mattes or blue-screen backing shots. When using the grid we take very careful records of what areas of the frame have been exposed in each pass through the camera. Then we can rewind and overlay another exposure in what we know to be a clear piece of film.

"We can get by with a lot of shots in which a starfield isn't necessary, or is in a different area of the frame. Where the ship must cross a starfield, however, we have rotoscoped mattes. Rotoscoping involves taking a sequence frame by frame, making line drawings, hand-painting the black mattes, then shooting that in high-contrast to actually create our matte and eventual effect. It's the only time we use an optical printer."

Solving the "Nostromo" Problems

Lighting the *Nostromo* and its processing refinery, which even in model form are 18 feet long, so that the illumination appears to emanate from a single point source—the nearest star—was something of a problem. Allder pointed out that there are no double shadows on the model, even though several lighting instruments in a row are used to illuminate it from the camera. "We use a series of flags to cross one light over to the other. Where the shadow created by one flag starts, the light from the second lighting instrument in the row starts." By careful placement of flags and lighting instruments the model can be made to appear to be lit from a single point-source.

The unique design of the ships and



The sets for *ALIEN* were rich in problematic floor effects. Note the streams of carbon dioxide gas expelled from the explorer's space suits as they prepare to enter the alien craft.

sets has been noted in many magazine articles and interviews. Brian Johnson adds his own comments to the story. "We had a whole series of people—Chris Foss, Ron Cobb and Ridley Scott—create sketches of the ships. It was my job to assess these and decide on the size of the model needed for any particular shot. In the end no one could really make up their minds as to how the *Nostromo* should look. Ridley is the kind of person who likes to see something in three dimensions before he actually says yes.

"My crew constructed a small *Nostromo* model—just the basic front section. I showed it to Ridley, who thought it might be alright, but that he would probably want to make a few changes. The talk went on and on and I was getting close to my shooting date and couldn't wait any longer. So I went ahead and built this huge model. When it was ready, we showed it to Ridley, I had my fingers crossed, be-

cause he could have turned around and said he didn't like it!

"But he did like it...I knew, though, that somewhere along the line he'd want to modify it. He modifies everything as he goes along. We changed the color about four or five times; it gradually got spikier, but the basic shape was always fairly similar. The rear end was altered slightly and it had lots of various probes and other things added to it."

The craft that the crew of the *Nostromo* finds on the surface of the planet is a Giger design. "We took Giger's sketch and sculpted a small replica without any detail—just the basic shape, for a test." Johnson explains the problems involved in transforming a two-dimensional sketch into a three-dimensional sculpture. "It's a common problem. A director will come to you with drawing; 'Hey, I've got this great sketch!' But it's a two-dimensional drawing, and when you put it into three dimensions it never looks the same. You have to be able to look at a sketch and say, 'That's going to look like a pile of rubbish. Why don't you let me have a go at making something that will be similar, but might have a totally different shape in three dimensions?'

"We showed the rough sculpted form of the Giger sketch to Ridley, who said that it was somewhere near what he would like. Then we built a huge one about 12 feet across that would be used for background estab-

lishing shots."

Allder recalls that "the model was built of polystyrene with a fiberglass 'skin.'" The model was also used in the long shots of the explorers as they approached the ship. "It was not a composite shot, however," smiles Johnson. "The explorers were tiny puppets with lights on them!"

Setting Up Floor Effects

Besides the use of photographic effects with their models, mattes and starfields, there are the floor effects—the mechanical devices that must be built for the full-scale, live-action set. These included the alien itself and all of its forms, special smoke, steam and fire effects.

One of the most interesting innovations was the use of a pulse laser on the planet set to produce the blue-beam effect that seemed to be protecting the egg chamber in the base of the alien ship.

"We used the laser," Johnson continues, "because Ridley wanted to do something different. We looked at all sorts of lasers while we were at Shepperton Studios; there is a company there that has lasers for hire. We got one on stage and played with it—puffed smoke and dry-ice fog through it. We shot several different sequences using it, but they were all cut out. Only the egg chamber sequence remains. I think it's very effective as some sort of weird protective ray or whatever—."

ALIEN

Special Effects Credits

Special Effects

Supervisors Brian Johnson and
Nick Allder

Floor Effects Supervisor

. Allan Bryce

Special Effects

Technicians David Watkins,
Phil Knowles, Roger Nichols,
Dennis Lowe, Neil Swan,
Guy Hudson

Matte Artist Ray Caple

Electronics and Video

Coordinator Dick Hewitt

Supervising Model

Makers Martin Bower,
Bill Pearson

Director of Photography for

Miniature Effects Denys Ayling

Alien Design H.R. Giger

Alien Head Effects

Created by Carlo Rambaldi

Small Alien Forms Co-designed
and Made by Roger Dicken

Additional Alien

Mechanics Carlo DeMarchis,
Dr. David Watling

Alien Effects

Coordinator Clinton Cavers

Alien Bolaji Badejo

Special Optical Effects Filmfex



Effects Supervisor Nick Allder lines up a shot through the viewfinder of a Panavision camera.

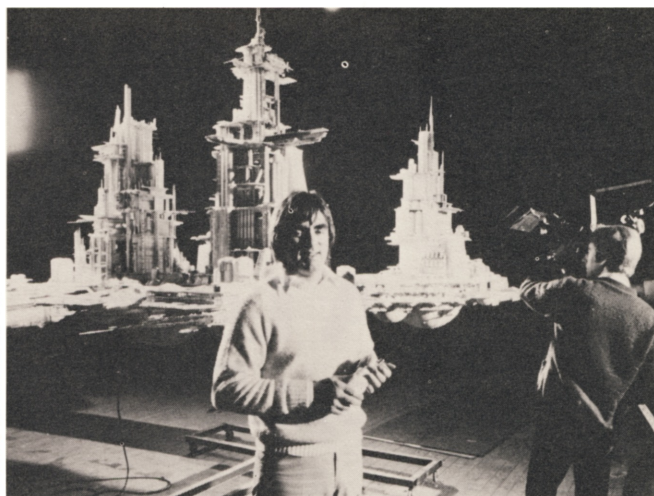
Perhaps one of *ALIEN*'s most startling and horrific sequences that makes extensive use of floor effects is the "Chest-Burster" scene. Kane, who has been attacked by the "Face-Hugger," is finally killed by the Chest-Burster—a larval stage of the alien creature—as it literally bursts from his chest, breaking the ribs outward, splattering Kane's blood everywhere and finally making a bee-line for the darkest regions of the *Nostromo*. The sequence is very convincing... to say the least.

Johnson recollects that day on the sound stage at Shepperton. "We did take after take of the Chest-Burster sequence. Some of it was too horrendous for words. The lighting cameraman, Derek Vanlint, who saw the rushes the next day, was sick after watching them. I think to get the R rating they used the most sophisticatedly convincing takes, but there were some that were really horrendous... bloody beyond belief."

The sequence, though, is a good example of a floor-effect problem. "Not that you do chest bursts everyday," Johnson laughs, "but the problem of setting a mechanism with some sort of dynamic action into a very confined space—this is one of the floor-effects man's regular problems."

"Poor John Hurt"

For the sequence in which the Chest-Burster actually breaks through John Hurt's rib cage, Johnson's crew built a special chest cavity for the hydraulic rams and the little puppet alien, actually a hand puppet. "Poor John Hurt," Johnson explains, "had to lay on foam-rubber pads which weren't very comfortable, with his head canted back at an angle. We used John's real head and built up a chest cavity that allowed us enough freedom of movement to get the mechanisms inside it; most of his body was below a cutaway section of the set, while we manipulated the mechanical chest. But there still wasn't much room to get all the mechanisms in there. You had to have quite a lot of leverage because we had to actually burst through the fabric and the layers of structure, bones and all the other things that were in there. We used a series of pneumatic arms and



Brian Johnson on one of the stages at Bray Studios. The model of the *Nostromo* is in the background. The *Nostromo* went through a long period of evolution and many coats of paint before everyone was satisfied.

levers which had tremendous force."

As the alien creature grows on board the *Nostromo*, at one point it leaves behind a trail of some slimy substance. "The slime was a substance with a lot of long chain polymers, so it would extend and look very oozy—pretty revolting stuff. We try to work with substances that are as non-toxic as possible. It is bad enough having to work with pyrotechnic materials, as people can get injured very easily. We do a bit of research into whatever chemicals we use to make sure that they are not going to harm anyone later on in life or whatever. In years past," Johnson admits, "carcinogens and other dangerous substances have been used without regard for the human damage they could cause. Unfortunately, most of the substances in the special-effects man's kit are fairly toxic, so we have to take precautions, such as proper ventilation and making sure the substances are labeled with warnings."

Johnson sighs when he remembers how much of their work never made it to the screen. Many sequences were filmed, among them the much-talked about "cocoon sequence." "There are very few of Ray Caples's matte paintings left in the film. They were cut out, not because there was anything wrong with them, but because when the movie was trimmed down to make it tighter, they were no longer needed.

"I'm sure that if the film is a great success at the box office, in the re-release (which seems to happen with every major picture that makes a lot of money, nowadays) they should allow Ridley complete control over

the second version. I think that he would like it to be just slightly longer and to include one or two extra bits and pieces; not just to be gory, but because he thinks (and I'm sure he's right) that there would be a greater dramatic effect."

As Johnson was moving directly from *ALIEN* to *Empire* again as SFX supervisor, I asked him to explain a bit about the role of a special-effects supervisor.

"Part of what being a supervisor is all about is being able to pick people who you know are going to come up with the goods. There's a lot more to it than just actually working on the movie. You're not a father figure, but you need to be something of an amateur psychologist. If you start having rows among the crew on a picture like *ALIEN* or *Star Wars*, you're in trouble.

"I'm a great believer in giving people responsibility and trusting them in the way they do things, but at the same time steering them in the direction you want them to go. In that way you get the best out of everybody. I do my best to get everybody a credit. The result is that you get total commitment.

"The effects on *ALIEN* are a total product of an amazing team of guys who worked together. If there are attributions of amazing special-effects work, you really must credit the work of the entire crew—they all worked their hearts out.

"A special-effects supervisor is only as good as the crew around him. With Nicky Allder and the rest of the crew, I think I've got the best special-effects team in the world!"

A LETTER FROM ENGLAND

British Special Effects Supervisor
George Gibbs shares some personal
observations about his work on
Flash Gordon

We started active preparations in April 1979, to be ready for shooting at the end of June 1979. *Flash Gordon* was always bound to be a heavy effects motion picture so I was on the lookout for the very best assistants I could find. The first choice was easy; Richard Conway—who later was to play a very important role in the special effects of *Flash Gordon*, it's worth a mention that he and I have worked together on and off for 12 years. My No. 2 assistant was David Watson who had helped me on a couple of previous movies.

Altogether I started with a key staff of 16, six engineers in the main workshop, 4 with the principal shooting unit, 4 assistants operating on the model unit, and an advance party of 2 more at EMI Studios Borehamwood.

The next step was to recruit top model makers, so I asked Martin Bower and Bill Pearson to build our models and help out on the model sets. I was delighted when they agreed as they were fresh from working on

ALIEN. As the model making became more hectic I also called in Christine Overs who happened to be working on a commercial in the studio. She was reputed to be very good with miniatures so I gave her a try. She turned out first class and I can boast that I was the first supervisor to have a female SFX assistant.

Once I got my crew together my next big problem was getting our workshops organized in three areas outside London, Dino had all the stages at Shepperton Studios booked, also at EMI Studios Borehamwood. But this still wasn't enough stage space so he rented one of the largest aircraft hangars in Europe at Weybridge Surrey built on the old Brooklands Motor Race Track which still in fact encircles the facility.

The hangar has a glass roof so the whole of the roof had to be blacked out, then literally miles of heavy electric cable installed around the hangar to supply great banks of 'Dino' flood lights for the blue backings. I understand we had the largest travelling matte blue backing ever built.

Special Effects Supervisor George Gibbs
displays one of the miniature flying carpets from *Arabian Adventure*.



PHOTO: DAVID HUTCHISON

We decided to locate the heavy engineering workshop in a separate hangar at Weybridge because we needed bags of space to build the giant combat disc for the Hawkmen's Sky City with the various gimbles. We also set up a model workshop in the same hangar, not enough as it turned out because of our heavy shooting schedule, just 16 weeks to do everything. We needed an additional but smaller engineering shop and another model shop at Shepperton Studios so that we could film at Weybridge or Shepperton simultaneously without major disruption or loss of time.

We still had EMI Studios Borehamwood to think about. Fortunately this was all first unit photography no models, so we set up just a small service workshop on site. As backup we had two standby trucks fully loaded with just about everything we could think of including the kitchen sink. Director Mike Hodges had the habit of visualizing some unusual effect completely on the spur of the moment, but his off the cuff ideas always turned up trumps.

His most successful idea, in my opinion, was the American football fight between Flash and Ming's Palace Guards on the arrival into Mingo City shortly after landing on the planet.

Whilst I was getting everything organized and on the move we started to build our models, Martin Bower and Bill Pearson had already begun construction on our model Dove executive plane and some of the space ships. I don't think they were overly impressed with the initial concept of the various rocket ships because they are rather way out, very close to the original Flash Gordon look I would say.

They were designed by Steve Spence a talented young art director who also designed all the weapons for the film among many other props, a name to remember for the future.

Meanwhile our little engineering department was busy rebuilding the full size fuselage of the Dove Executive aircraft that crashes into the giant glasshouse of Dr. Zarkov (Chaim Topol) with Flash and Dale the only two passengers inside it, the crew

having mysteriously disappeared.

We finally started first unit shooting in Scotland on the Isle of Skye, chosen because it has a similar landscape to Maine on the American Eastern Seaboard. We were there for 10 days shooting flying sequences leading up to the plane crash. This was a good way to start a long picture because the crew was together on a very small island and we got to know each other very quickly.

Meanwhile Richard Conway was looking after the model shooting unit for me preparing our scale glass house set for the plane crash sequence and Zarkov's rocket miniature for the trip to Mongo and his attempt to save the earth from destruction.

For the rocket launch we wanted to get some really good flare effects to simulate the massive real life rocket motors. I went first to a Defense Department factory that manufactures flares for guided missiles. They had just the thing, each flare was made to the highest precision including final X-rays for otherwise invisible faults (flares with steel cases have been known to explode on occasion because of cracks in the compound). They burned for exactly 15 seconds every time, starting with red for 2 seconds, changing to white this gave a great heat effect inside the greenhouse as the rocket gained liftoff.

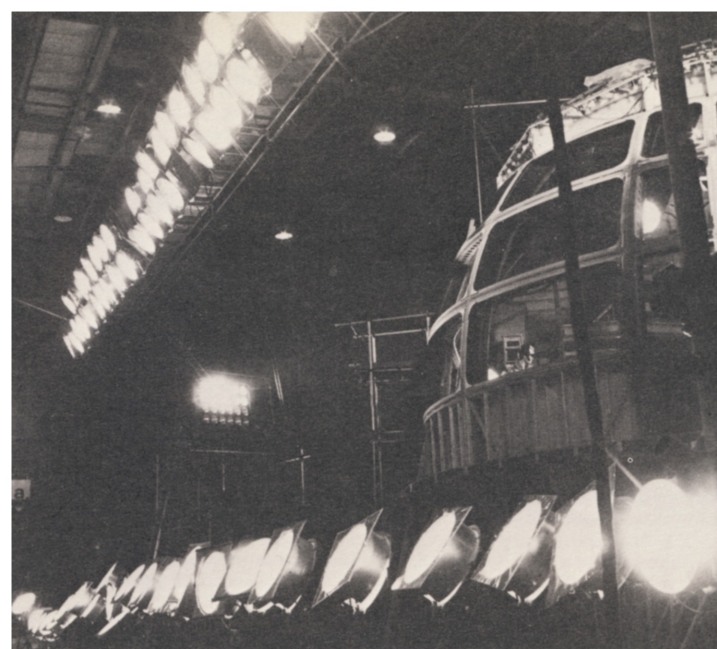
Building the combat disc was a worry for me. It had to be 30 feet in the air with 96 steel spikes that rise and fall in blocks of 12 or individually. Apart from this built-in hazard—Mike Hodges insisted on using Flash and Barin (Timothy Dalton) themselves on the disc rather than the stuntmen—the disc was made to tip more than 15 degrees in any direction, tricky to even stand on let alone fight with whips at the same time. We fashioned each spike like an air ram, working on as little as 4 pounds air pressure controlled by 6 volt electric solenoids. The reason for such low pressure was to insure they would instantly retract if the actors fell on them accidentally.

The next big problem was a method of detonating explosions around the Hawkmen remembering they were naked except for leather briefs and wings. Dino De Laurentiis wanted me to make the explosions much bigger, but when I explained the reason he quickly understood. Its totally different in a war picture when actors are well covered with uniforms to protect them from the heat of explosions.

We also had some great fun on the Arboria Forest set which filled H Stage at Shepperton with its giant trees and steaming swamps. Sam Jones turned out to be a real pro. He did all his own stunts. The swamp looked and felt really horrific. The monster that rose out of the swamp



Mike Hodges directs a rehearsal with Max Von Sydow.



Enormous quantities of light were needed to illuminate acres of blue screens.



The Emphyrogen cast in foam latex from Martin Bower's prototype.

like a giant spider was another continuing saga. One week we would get a memo to say it was out of the film, the very next day it would be back in.

Just as Flash laid down to rest after escaping from the swamp the spider attacked and began to eat him alive. Sam had to be covered with all the slimy substances we had mixed up into a cocktail to simulate the monster's digestive juices.

We had already completed about eight weeks filming when we decided to start with the cloud tank, already built during the preparation period and it had worked perfectly on our first test. (9' 6" x 6' 4" dimensions built from Polycarbonate acrylic sheet). This form of perspex was used because even with the great weight of water we were using it would only have to be $\frac{3}{8}$ " thick.

To use glass with such high water pressure would have been far too thick and not optically viable to the same degree as clear perspex. I personally was still very much involved with the first unit filming at EMI Studios, so Richard Conway had to continue alone at Shepperton Studios to work out some good possibilities for cloud backgrounds and Galaxies.

Creating the Mongo atmospheres was an exciting part of our work on *Flash Gordon*. The original notion was to use microphotography but by this time the first unit had proceeded with acres of blue screen backings thus committing the film to sky plates.

The preliminary micro plates were

extremely interesting but they lacked depth and credibility as atmospheres. They also posed insurmountable continuity problems as it was virtually impossible to recreate a constant effect.

We had already produced a fine surreal storm cloud effect on our first tank test, so we decided to use the same technique for most of the tank work on cloud formations.

Director Mike Hodges and Dino De Laurentiis were very pleased with the results. I'm sorry that there is not more of the cloud effects in the film. The colors and movements with different shapes and forms would actually make an interesting short film of its own.

By the time the first unit shooting was complete we had a lot of model shots still to do, Richard Conway and I mapped out the model shots together. Crashing the war rocket into Mingo City had to be a one off take because we only had one rocket which was inevitably badly damaged when it crashed into the model palace. Looking back most of our effects were one take deals because we had such a fast shooting schedule.

The one sequence that will always stay in my mind is the Hawkmen attack on Ming's war rocket. Art Director John Graysmark had a full size section of the war rocket built in the hangar at Weybridge some 200 feet long and 50 feet high. We covered it with made up explosive charges, numbered 1 to 100 firing 20 off per

take so we could have 5 tries without a reload, which between takes would have taken up far too much time. I had a 35' high tower built, with my firing boxes and a plan of the rocket on the top platform, since a good view of the Hawkmen flying in was essential. Some had charges attached to them and others had to crash full tilt into the rocket.

The Hawkmen were flying in at about 50 feet from the ground with big bangs going off all around them. In situations like this the stuntmen and special effects team have to work very closely together to make sure stuntmen have complete confidence in the special effects system, because the heat of an explosion being detonated prematurely could actually make the spring steel supporting wires snap like cotton.

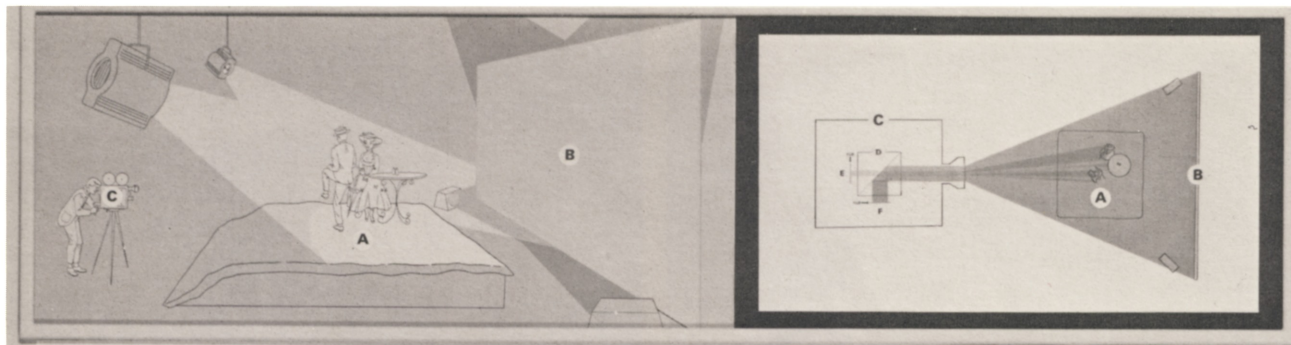
The special effects in *Flash Gordon* should not be compared with other films. We were not in any sense trying to match or out do the next or the last space fantasy films. Perfection was not our aim, but to give a feel of the original *Flash Gordon* stories which started as a newspaper strip back in the early thirties.

We also had to keep in mind constantly that the fundamental purpose of the cinema is to entertain. ●

George Gibbs
Special Effects
Supervisor
Flash Gordon
1980-81

TRAVELING MATTES USING THE DISNEY SODIUM SYSTEM

A traveling matte is a means to combine two or more separately photographed scenes into one picture. In certain sequences of Disney's *Mary Poppins*, the foreground (actors and/or animated characters) and the background (existing or painted) were photographed at different times and places, and the composite images produced were later combined during the processing to make one composite picture.



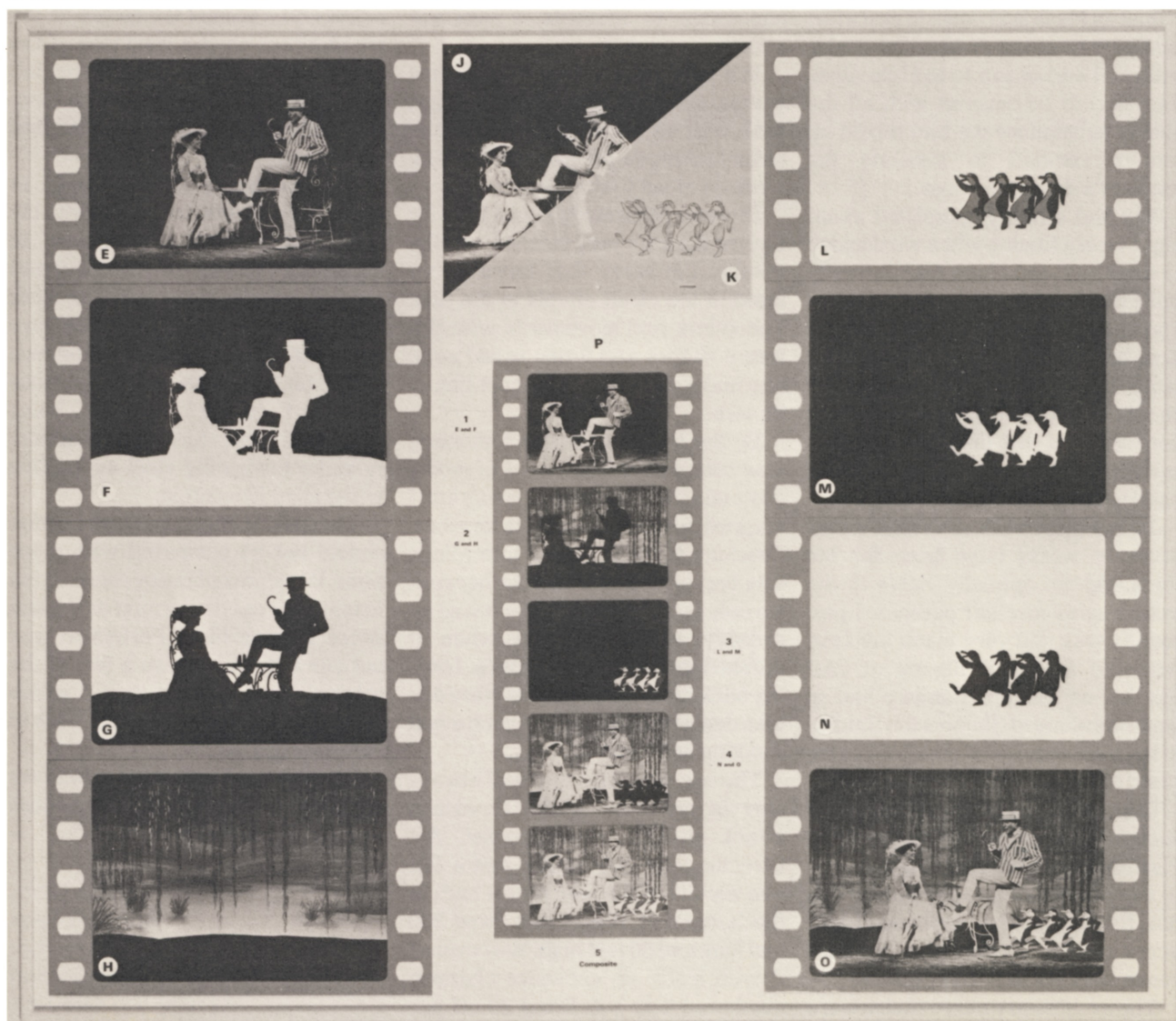
1. Actors on foreground platform **A** are photographed under white light against a specially lighted sodium screen **B**. This particular sodium color is used because it is a very narrow band in the spectrum, and its absence from the color negative has no discernible effect in the color of the scene as photographed by the beam splitting camera **C**.

2. This color image goes through a prism **D** inside the camera and is recorded on a color film strip **E**. The sodium screen color is reflected within the prism and recorded on a separate black and white film strip as a negative silhouette image **F**. (See enlargements of film strips **E** and **F** below.)

3. The use of the prism makes it possible to shoot live action **E** and form a corresponding traveling matte simultaneously. From this negative matte **F** a positive matte **G** is made. Note that the foreground platform upon which the actors stand **E** is designed to blend in with the painted background **H**.

4. Blow-up prints **J**, black and white enlargements of individual frames are made. These blow-up prints enable the animator to plot out the action of the animated characters. The animated drawings **K** are then reproduced on cels and carefully painted.

5. These cels are photographed **L** in color under normal front lighting by the animation camera. A negative traveling matte **M** is made by backlighting the cels to create a silhouette image and re-shooting them on black and white film. From the negative matte a positive matte **N** is made. All elements are combined to form the composite print **O**. (See **P**, steps 1 through 5.)





Flying Down to Mongo

OR

The TRAVELING MATTE BLUES

Photographic effects veteran Frank Van der Veer is a second generation Oscar winner. His father, the first man to film both the North and South Poles, won the 1930 Award for Photographic Achievement. Frank Van der Veer picked up his for *King Kong* in 1977. His reputation in photographic effects began when he joined the photographic effects department at 20th Century-Fox in 1950. After seven action-packed "apprenticeship" years, he moved to Warner Brothers for a further six to expand his techniques in the field of blue screen traveling matte photography.

Since that time he has probably been called upon to do more blue-screen work than anyone else in Hollywood. Blue screen traveling mattes require skill, experience, care and plenty of time in the lab in order to achieve the degree of precision that modern audiences and producers demand. Van der Veer's recent successes with blue-screen effects in the De Laurentiis *King Kong* and Spielberg's 1941 made him the logical choice to handle the photographic effects for *Flash Gordon*.

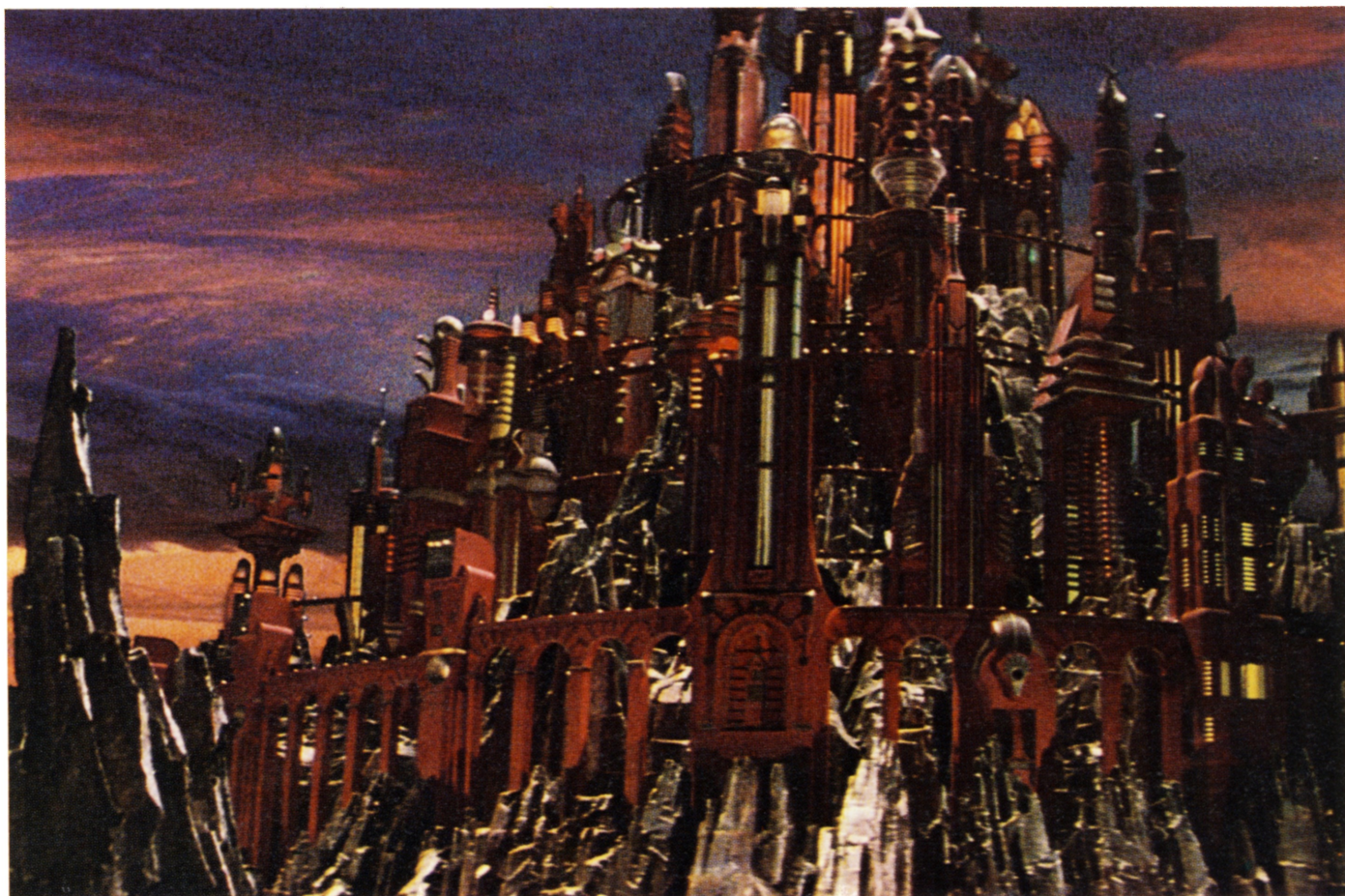
The De Laurentiis *Flash Gordon*

proved to be an enormous undertaking in terms of photographic effects, not so much because of *what* had to be done, but *how much* had to be done in a relatively short time. "In my estimation," says Van der Veer, "*Flash Gordon* has more photographic effects work in it than any other movie ever made. I'd say 75 per cent of the movie features some sort of effect."

Van der Veer emphasizes how this stands in marked contrast to the films of the 60s and early 70s that had no need of effects—the pre-*Star Wars* days. "Until recently, all movies seemed to start with a fade-in and end with a fade-out. No effects in between, just so-called 'realism.' I refer to it as the 'Life Can Be Miserable' period."

But now with the fashions of the ash-can school of filmmaking, virtually vanishing from the movie houses, imagination, adventure, tall tales and high excitement are replacing the seamy slice of life scripts and placing ever-increasing burdens on special effects artists. "By way of illustration," explains Van der Veer, "consider *Superman*. On that film it was very important to convince the audience that a man could fly. I think the

Above right: Blue screen insert with live action set shot. Model rocket and tank effect sky have been matted into the background opening in Ming's palace. **Right:** The miniature set of Ming's palace with sky effect matted in.





PHOTOS © 1980 WARNER BROS. INC.

The war rocket is poised to crash into the model of Mong's City. Effects supervisor George Gibbs states, "Crashing the war rocket into Ming's City had to be a 'one take' affair."

people on that film did a marvellous job. What complicates ours is the fact that we don't have just one man flying in a scene. . . we have one thousand Hawkmen. Also, they are flying in a very unusual setting.

"Whereas in *Superman the Man of*

Steel was flying against a fairly realistic and familiar backdrop like New York City, our Hawkmen are flying against a setting of the Mongo Galaxy, sheer fantasy. Every environment these characters enter differs from the one preceding it. Nothing

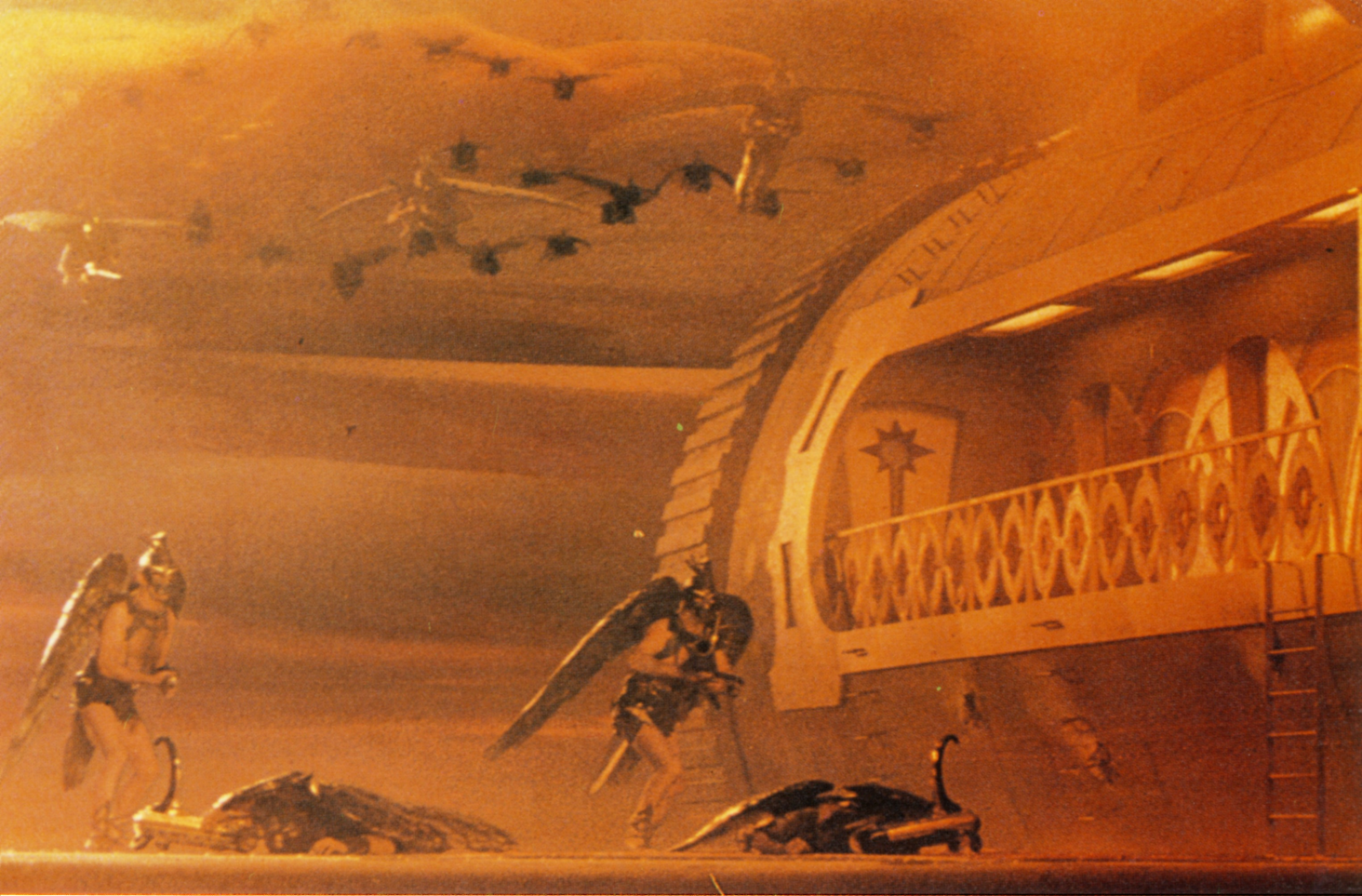
can be conventional. The skies have to be different, the land is unique, the clothing like nothing you have ever seen and the architecture literally 'out of this world.' Our job is to pull all this off realistically, so the whole film doesn't look like one gigantic effect."



Director of Photography Gil Taylor.



Brian Blessed wings to the rescue in this completed blue screen optical composite.



Hawkmen on the wing. Director Hodges admits that he walked a tightrope between comic strip art and reality.

Still, *Flash Gordon* is very nearly "one long effect." After principal photography wrapped in December of '79, Frank Van der Veer and his team at Van der Veer Photo Effects had less than nine months to complete an unheard of 600 composites!

'Flash's' Greatest Challenge

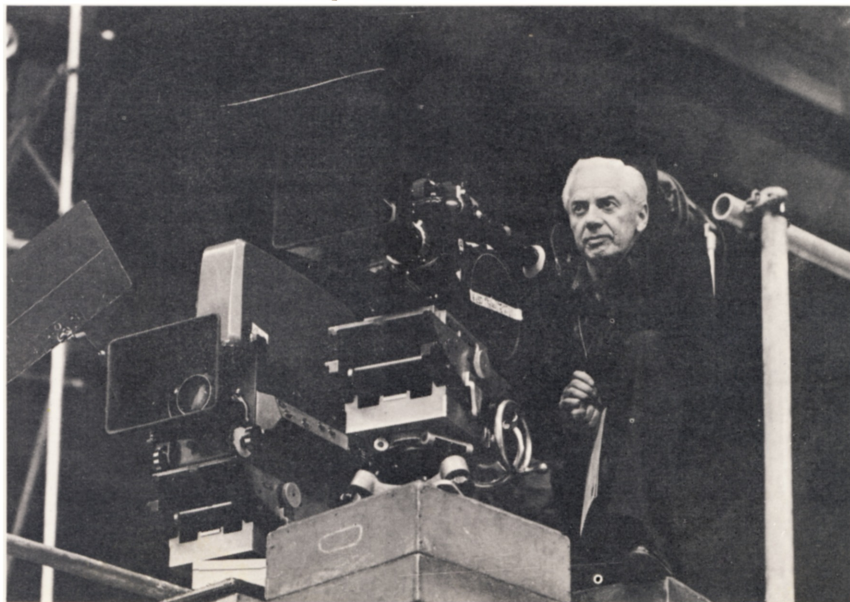
But before the months of round-the-clock tedious time-consuming optical compositing, there were the months spent in England shooting the seemingly endless special effects sequences. The Hawkmen proved to be

the greatest challenge since De Laurentiis and his designers envisioned sequences with hundreds and hundreds of Hawkmen in the air flying to the rescue. Van der Veer explains a bit of the process:

"We decided we would be able to fly and control seven or eight men at a time. In order to make the hawkmen shots look like hundreds of them in the air, we would have to combine several shots in the optical printer. We put together shots which combined as many as 20 different blue-screened elements to make a single shot.

"But to photograph seven or eight Hawkmen at a time, it was necessary to build an enormous blue-screen. In the course of the production we used many different types and sizes, the screen we built for the Hawkmen was 60 feet high and 100 feet wide."

The first problem to be faced was how to light a screen of that size to the requirements of blue-screen photography. Van der Veer prefers to light his blue-screen with arcs, when possi-



Frank Van der Veer lines up a shot with an Arri 35BL and a Cinema Products XR 35.



A video adapter has been rigged to the Arriflex 35BL providing the camera operator with video recording and monitoring capabilities. *Flash* was shot in Todd-AO 35 format.

ble; arcs have a lot more blue in them and the object in blue screen photography is to get as much separation between the blue in the background and the warmer light in the foreground as possible. "Unfortunately," Van der Veer continues, "there are very few arc lights in London. Of course, it's practically impossible to light a screen that large with arcs, anyway. Can you imagine how many arcs would be required? And can you imagine how many men you'd have manning those arcs? And can you imagine all the scaffolding you'd have to support those arcs? And then of course *somebody* would always be trimming an arc! Not only that, but in trimming the arc, when they swing the lamp around to put a new arc in, they put it back the way they *think* they had it before, right? When you have 100 guys doing that...they don't get back to the same place! Then, too, you'd have a tremendous smoke problem.

"We finally had to do it with incandescent lights. We built special lights which were clusters of quartz-

halogen lights; we called them 'Dinos.' They put out a tremendous amount of heat, but they also put out a tremendous amount of light; just to light that one background screen took a million watts of power."

Additional power was required to light the seven or eight sturdy stuntmen who were required to dangle for hours in their roles as Hawkmen. Stuntmen were called upon to handle the flying sequences because of the stamina required to keep their bodies horizontal while hanging from wires attached to a hip harness. Proper flying form required the Hawkmen to keep their heads up so they would be looking forward when flying (instead of looking down) and their legs and backs arched. The work was tiring, awkward and uncomfortable.

At first it was thought that the Hawkmen would do the flying and the camera would remain stationary, but it soon became apparent that there was just no way to move that many people; so the decision was made to "fly" the camera with the Hawkmen hanging in a stationary position while

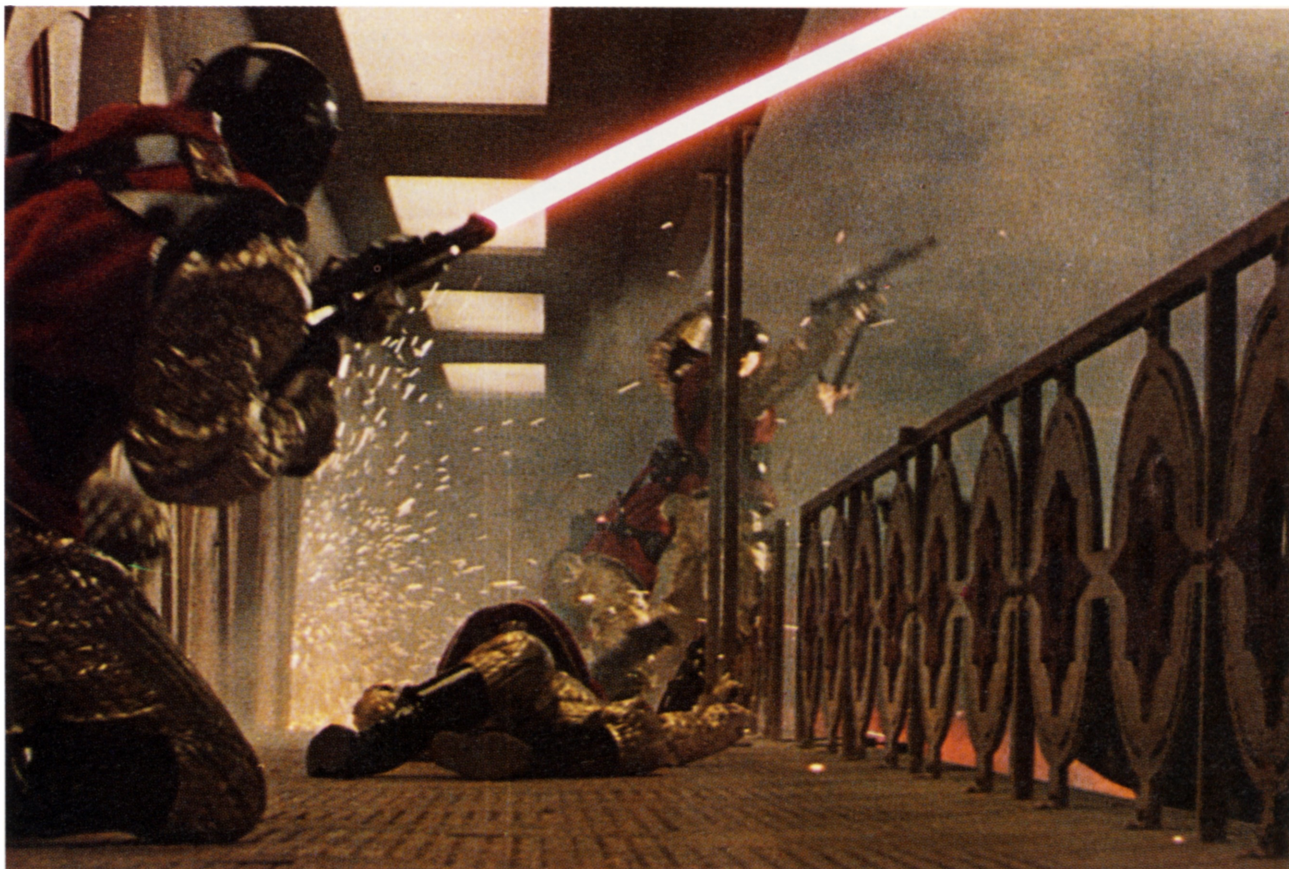
flapping their wings—the camera would supply the flying effect.

Winging It

The flapping wings proved to be another problem. Even the wings were rigged on wires to control the movement. If all this sounds like a situation that could easily go haywire...you're right. Van der Veer describes an average morning.

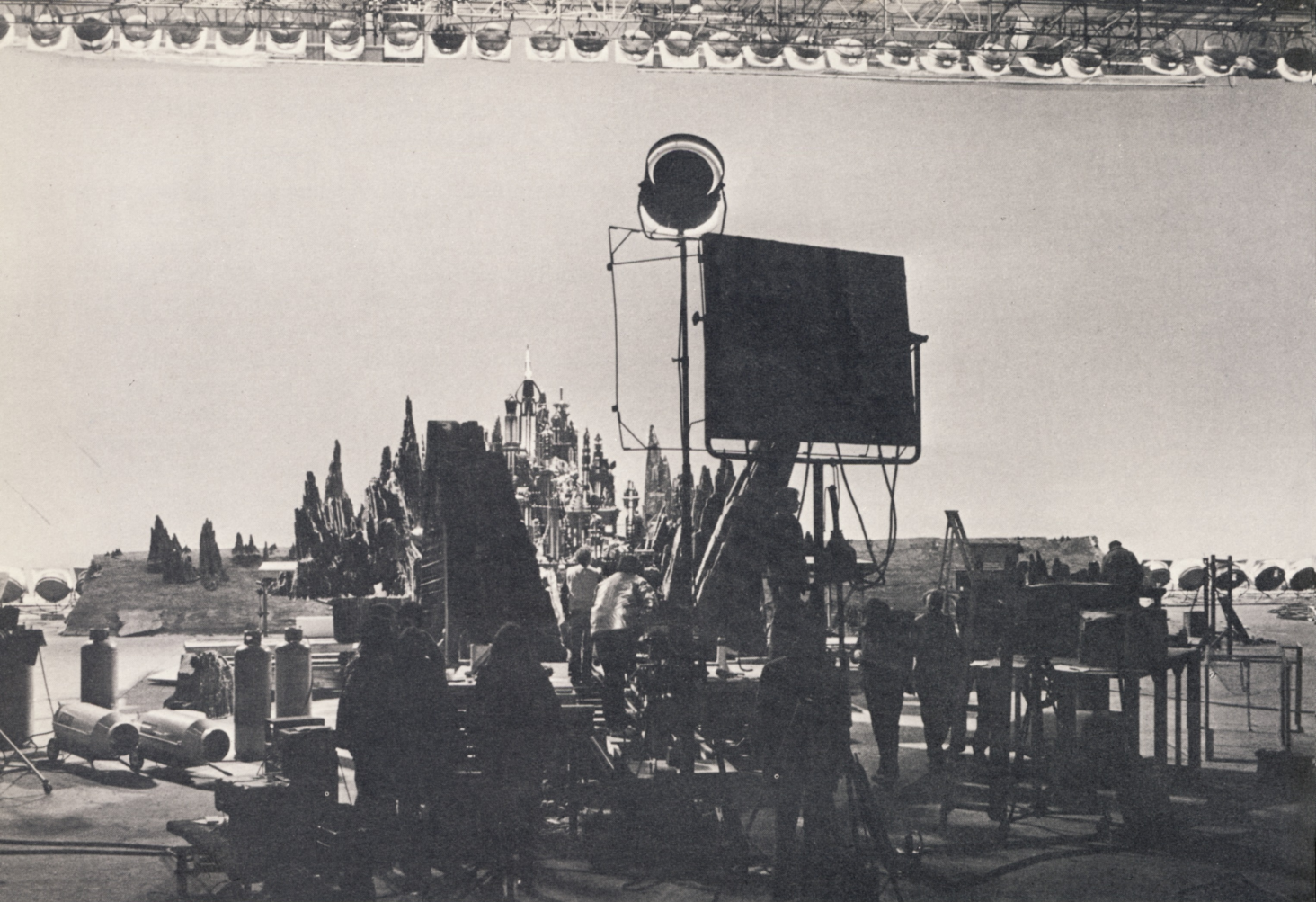
"All right, so you haul up the Hawkmen in front of the blue screen for a take. All of a sudden you notice the second guy from the left—his right wing isn't working right. So you fix that and set up again. Then, oops, the third guy on the right forgot his gun. O.K., once more. Then you notice that the people pulling the wing wires, making them flap are not together—some are too fast, some are too slow. Well, after four minutes in the air, the guys are getting tired—they can't hold their bodies in that awkward position for more than four minutes.

Then, too, the constant friction of the wings on the wires kept rubbing the blue paint off, so the wires are



PHOTOS: © 1980 FAMOUS FILMS

Art Director Graysmark had a full size section of the war rocket built, 200' long and 50' high. Laser effects were added optically.

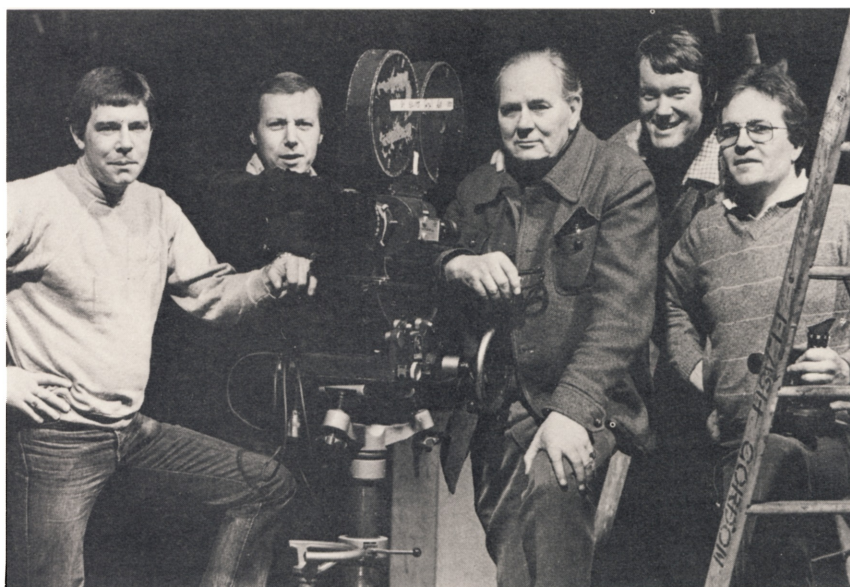


Ming's palatial city in model form is readied for filming against one of the largest blue screens in the world.

constantly having to be repainted and you have to make sure to light the wires as carefully as possible so they don't show.

"Finally, after everything is flying and moving properly you have to worry about the camera—you have to move the camera or zoom the lens or whatever to get the illusion of movement. Sometimes the Hawkmen are hovering, sometimes they are zooming, sometimes they are going away from you and sometimes they are coming towards you and, of course, those movements require different types of rigging; which, of course, takes time to set up.

"We had some 600 blue screen shots to do for this picture. The reason there were so many was because of the alien sky effects. On *Mongo* all of the skies are very unique, so if there is a window in the set or a doorway or anything that lets you see to the outside, it meant that blue-screen photography was necessary to insert one of these unique sky effects. The absolutely gorgeous clouds and skies took



The camera crew for *Flash Gordon* with Gil Taylor center and Effects Supervisor George Gibbs peering over Taylor's left shoulder.

months and months of work to produce. They are the work of Richard Conway and his associates, Harry Oakes, B.S.C.; David Litchfield and Terry Pearce.

"The sky and cloud effects took a

tremendous amount of expertise and experimentation; the results are unbelievable—they have stratas that go in different directions, they have different types and colors of clouds. Arborea is greenish, of course;

PHOTOS: © 1980 FAMOUS FILMS

Ming's city is reds, yellows; Sky City was purples, cyans and blues."

The sky effects were achieved in a tank and bring to mind the techniques that Doug Trumbull's crew used to create the startling cloud effects for *Close Encounters*. It was no holds barred for the tank experiments and everyone seemed anxious to try all sorts of things to see what sort of cloud effects they would get. "Guys would go to the grocery store and start pulling down different kinds of detergents and cleaning fluids to try out. One enterprising experimenter even made off with his wife's toilet bowl cleaner. We put it in the sky tank and it was the most gorgeous effect you'd ever want to see!"

Conway and his team worked with a tank measuring nine by six by four feet and were able to develop a variety of tricks and techniques. "For example," recalls Van der Veer, "they found they could use the surface as a mirror and make it look twice as deep; a motion control camera was used a few times to move

very slowly across the tank. Copper tubing with little holes in it was used to dispense pigment into the tank. Getting that just right took a bit of experimentation; if you squirt it in there too fast, in nothing flat you have a tank of mud. But after a while, Conway and his crew began working with the temperature of the water and learning how to control the currents. Even after the tank had been filled with clear water and allowed to sit for an hour or so, there were still very slight currents circulating in the tank. These currents would take different pigments in slightly different directions as they were inserted. At times layers were built using different densities and temperatures. It was a tremendous job, since so many shots required skies.

"A variety of camera speeds were used. If the tank was very quiet and the currents moving very slowly we could shoot as little as four frames a second. Also you could make one run on a tank and go right ahead and make another run that would look

quite different. The variety of forms seemed to be infinite. After you did a few shots, you could change the lighting and the colors of the gels on the lights and shoot again before you had to empty the tank and start all over."

Everywhere a Blue Screen

All of the skies and cloud footage served as background plates for the blue-screen photography. And with so many sets having doors, windows and openings to the "outside," blue screens were everywhere. "In addition to the 100 by 60 foot screen, there was a U-shaped screen that ran for 100 feet down one leg of the "U" then curved for another 100 feet and then ran another 100 feet up the other leg of the "U;" so we had a screen 300 feet by 35 feet high. We had them in all sizes down to little teeny-weeny ones, which were usually Stewart T-Matte Blue Screens instead of the painted type; we used these for small areas such as behind windows. The rest of the screens were painted blue



War rocket model was photographed with smoke against a blue screen with Conway's skies optically composited by Frank Van der Veer.



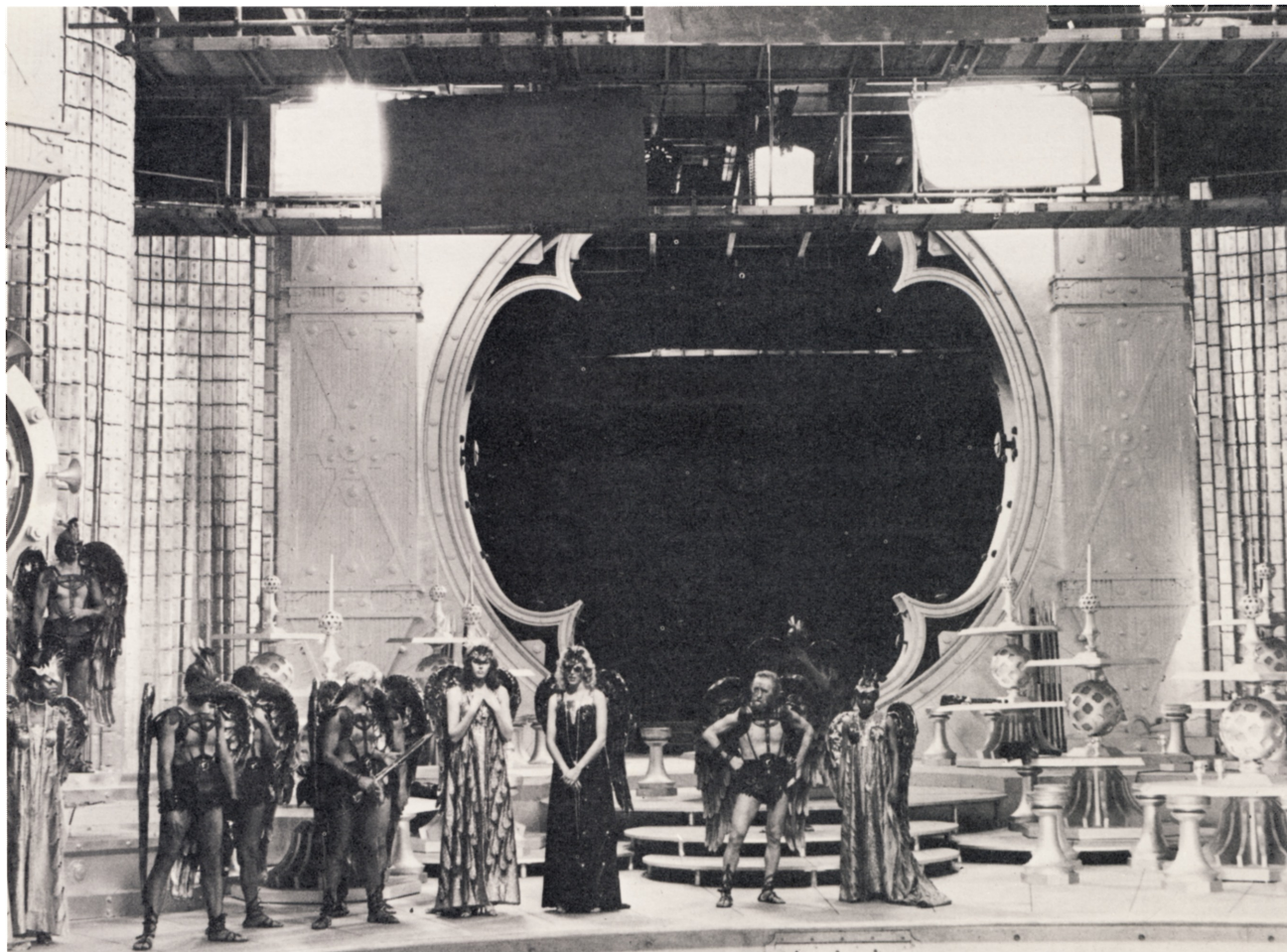
Frank Van der Veer sets up a test composite on his new electronic "optical" printer.

and lit with incandescents. With so many windows and openings, it meant that scenes which would be shot normally on any other film became blue screen problems for us."

After all of the separate elements were photographed, the gargantuan task of optical compositing had to be faced. In order to get all of the bits and pieces to fit together properly, a long

process of trial and error begins. It is not unusual for a given shot to require eight or nine attempts in compositing before a satisfactory optical composite is achieved—that is, one without "fringing" or color distortion or any one of several other "tell-tales" that make for an unsatisfactory composite. All of this takes time...and skill. There was skill aplenty, but time was very short. Van der Veer is a frank admirer of *Flash Gordon* producer Dino De Laurentiis. "A man with a lot of horse sense... - except when he tells you the delivery date he has in mind!"

"In order to make the Hawkmen look like hundreds in the air when we only shot them seven or eight at a time, we had to make up layers of our shots. And, of course, maybe there is a miniature in the shot and always the special skies. Also a lot of the Hawkmen flying sequences involved explosions with the Hawkmen firing weapons and being fired at. There is lots of smoke and flame and fire—things that are usually 'no-no's' for



Even interior sets required blue-screen setups, since the sky of the planet Mongo is visible through openings and windows.



Hawkmen were required to dangle by wire in front of blue-screens for hours to film the complicated attack of the Hawkmen sequence. There were over 600 bluescreen shots that had to be assembled in *Flash Gordon*. Many were very complex shots involving smoke, fire and explosions.

'FLASH GORDON'

Effects Credits

Produced by **Dino De Laurentiis**
 Directed by **Mike Hodges**
 Director of Photography . **Gil Taylor, B.S.C**
 Production, Costumes and Sets
 Designed by **Danilo Donati**
 Supervising Art Director . **John Graysmark**
 Supervising Special Photographic
 Effects . . . **Frank Van der Veer, A.S.C.**
 Assisted by **Barry Nolan**
 Special Effects Supervisor . . **George Gibbs**
 Special Effects Consultant . **Glen Robinson**
 Art Director—Models . . . **Norman Dorme**
 Special Effects—
 Models and Skies . . . **Richard Conway**
 Special Effects Editor **Chris Kelly**
 Skies and Clouds:
 Lighting
 Cameraman **Harry Oakes B.S.C.**
 Camera Operator **David Litchfield**
 Focus **Terry Pearce**
 Special Effects Assistants . . **Dave Watson,**
Pierre Tilley, Michael White
 Special Effects Flying **Derek Botell**
 Model Makers **Martin Bower,**
Christine Overs, Bill Pearson, Don Sargent
 Optical Effects
 by **Van der Veer Photo Effects**
 Blue Screen Composites
 **Greg Van der Veer**
 Optical Cameramen **Hugh Wade,**
Ray Monahan
 Optical Technicians **Dick Ramirez,**
Lyn Gerry, Ralph Gordon, Rick Rothbart
 Matte Paintings **Lou Lichtenfield**
Bob Scifo
 Administrative Assistants . . **Jerry Cormier**
Diana Bull

blue-screen work. You can imagine what it meant when we had to have one no-no working with another no-no over a couple of other no-no's which are over a couple of other no-no's. We put together blue screen shots which combined as many as 20 different blue-screen elements to make a single shot. The capture of the battle rocket—which is reel 10 of the picture—is the most impressive of all the reels; it has the look of thousands of Hawkmen winging to the attack."

In the final analysis, when the quality and content of the work comes up for judgement the harshest critic is usually the artist himself. Frank Van der Veer is no exception to this rule. "Actually, where as you are never truly happy with what you do—at least I'm not, I can always see a way to get better results given the time—I feel that with the length of time we had to put these 600 shots together, we did an almost impossible job.

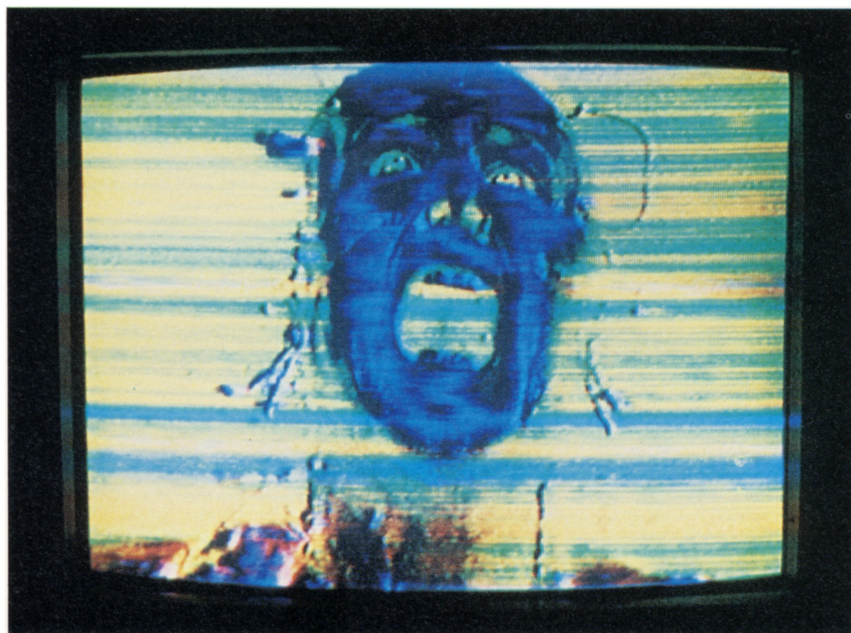
"I really enjoyed working on the film and I'm very fond of Dino. He's a wonderful man. If you think he's making the wrong decision, you can talk to him about it. If you have a legitimate reason for wanting to change some-

thing, he listens to you. And he doesn't care if it costs more money as long as it's better. If it's not better, he's not interested. And it's only one man—you don't have to fight a committee.

"I believe that the most important thing is for the producer to have a good experience when he is working with photographic effects or any kind of effects. If he has a good experience, he will be inclined to have another one. If he has a bad one, he'll start making Westerns again or something.

"All in all, though, it was an enjoyable experience with tremendous pressure. And if all of the things we did are not truly perfect, I think they work within the context of the picture. What made it all possible was the quality of our crew. We are not a large crew but we all know what we are doing. That's my basic philosophy. Instead of getting 70 people, you get 10 people who know seven things. You're much better off and you're better organized— everybody knows what's expected of them and everybody does it. I just have a marvelous crew and I'm very proud of them."

ART, SCIENCE AND ALTERED STATES



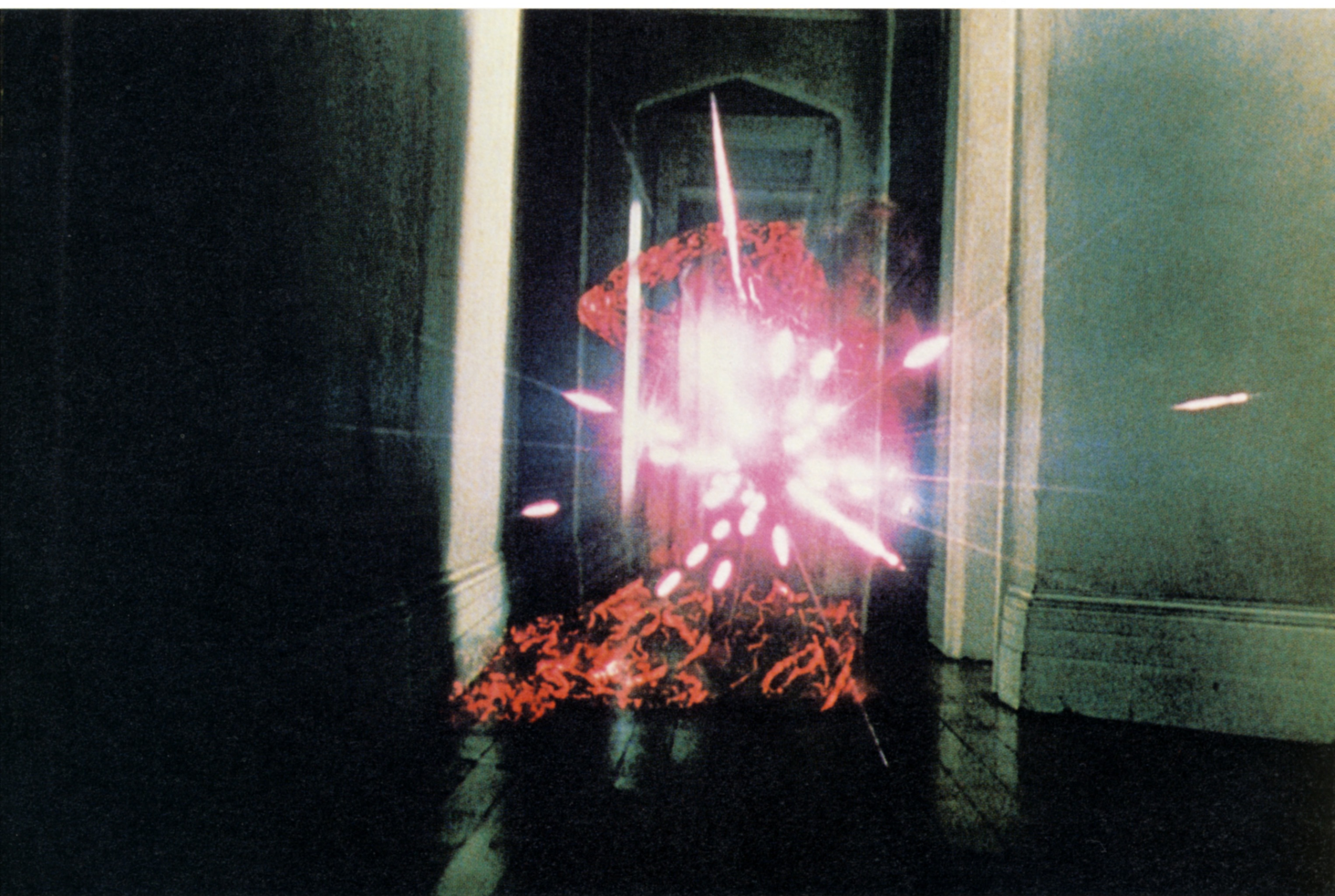
Paddy Chayefsky's *Altered States* comes to the screen in a form that demands new levels of technical and artistic excellence from its creators.

Paddy Chayefsky's novel *Altered States*, published in 1978, moved very quickly into production as a major motion picture. Quite a number of directors, designers and effects artists had to be approached, however, before a production team willing to tackle the very unusual production problems was assembled. Chayefsky has won three Academy Awards for his

screenplays, but *Altered States* was his first novel. The screenplay, though, is credited to Sidney Aaron, Chayefsky's pseudonym, due to a dispute with the film's director Ken Russell.

The story explores the investigations of a young scientist's experiments with altered states of consciousness, and the power of the mind to effect physiological changes

Above: Jessup's (William Hurt) image in the TV monitor, lets us see what's happening inside the isolation tank. **Right:** The final transformation sequence.







Left and inset: Detail of William Hurt as Jessup in Dick Smith's full body suit for one of the metamorphosis sequences. Smith demonstrates to director Russell the operation of a mechanical arm. **Above:** Blair Brown in different body suits before optical enhancement.

in the body. It uses the isolation tank experiments of John Lilly as a departure point.

Dean of American makeup artists Dick Smith created the special appliances for the actor's transformations and young Bran Ferren of Associates and Ferren was hired to create the mechanical special effects.

Ferren, who is best known for his rock concert effects and Broadway stage effects in *Evita* and *Crucifer of Blood* and *Frankenstein*, made such an impression on Ken Russell that he was asked to handle the optical end of the effects problems as well. Ferren's strong background in live-theatre stage effects proved to be an invaluable asset.

Magic on Film

Ferren, whose sandy red hair, penetrating blue eyes and husky six-foot frame seem more suitable to a soccer player, had very definite

ideas for the special effects. "My approach, after reading the book and talking to Paddy, was that we shouldn't be making a special effects film. We should use magic. That is, when we have a specific image in mind, we should actually make it happen and take a picture of it. In other words: do it for real and film it!

"I thought that that approach would look an awful lot more convincing than, say, 700 extremely clever techniques brought to bear in the optical house or miniature sets or whatever...."

So they didn't use miniatures. "Whenever you see a strange hallucinogenic scene which has no direct relevance other than to present one, wild image, we'd go out and build a set or go tromping around to a location or go do something and shoot it that way. Hopefully, and I'm the worst person to judge this since I was so close to it

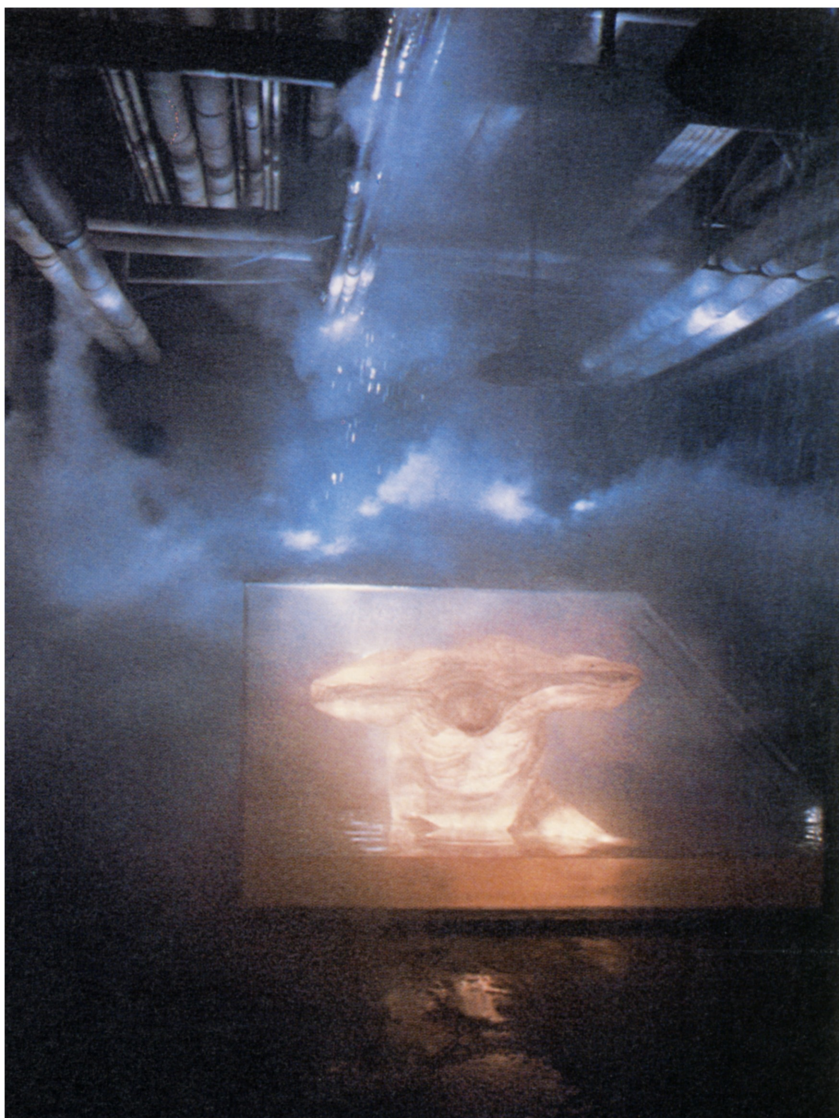
for so long, it gives it a kind of unique look." Ferren made a point of avoiding the usual cut-away-for-the-special-effects-shot handicap, so that the audience would be more apt to react to the situation rather than the effect.

"I want the audience to say: 'Oh, look at what's happening in that room!' rather than, 'Oh, look at that clever effect.'"

The demands of the script in many instances, however, make it impossible for this sort of aesthetic to be maintained. "For example," explains Ferren, "when you see a burning cross zooming in on a person and then heading out into infinity, obviously this is not something that happens within one's direct frame of physical experience, so it violates that standard.

"However, for the 'throat' and whirlpool sequences—and a good deal of the stuff that happens at the end of the film—I think we've been

Right: The transparent tank with the specially lit suit designed to look as if it was glowing. Jessup is supposed to be emitting so much energy that his image becomes visible through the walls. Artist Dick Smith was concerned with what happened to all of this energy, which the film never really makes clear. **Below:** A close-up of one of Dick Smith's makeups with optical enhancement.



Above: A close-up of Jessup's final transformation with optical enhancement by Bran Ferren and his team.

Below: The whirlpool tank built with plexiglass to permit lighting from below. Construction by Chuck Gaspar. Blair Brown had to move into the whirlpool, fighting the force of the water. No optical trickery here—it's real.



very successful by starting out with the premise that we're doing magic, live, and then following up in post-production with opticals to complement and enhance things. Unfortunately, a significant number of things we needed for enhancement had never been done before and therefore we had to develop techniques and technologies to do them—which gets to be expensive!"

New Technology

What techniques and technologies did Ferren have to develop that weren't off-the-shelf? "Well," Ferren says with a laugh "ignoring the straightforward physical and mechanical solutions to specialized set-ups in composite front projection, or the creation of a 'cosmic' whirlpool in a specially constructed set of inch-and-a-quarter plexiglass with high pressure pumps creating a vortex of thousands of gallons of water, which has to be lit and have a live actor walk into it...and come out alive...Ignoring all of that,

which is just a matter of working out a solution and doing it, the most difficult problems were in post-production.

"We had to develop very sophisticated matting techniques that would enable us to go back into scenes that were complete, and not reshootable, to selectively alter elements within a scene. We would have to change a person, change or correct a portion of a room differently from another portion of a room. There were any number of little things that we had to do in order to make the continuity of some of the more difficult sequences work. For example, we had to reposition things within a scene so that they matched during very fast cutting. We had a lot of non-matched footage which we had to match—a lot of non-locked-down, camera-in-motion shots which had to be repositioned dynamically in motion in order to make them fit together," Ferren explains.

"We used a lot of computer-

assisted rotoscoping. Generally we would have to generate a protection matte for a given area in order to do something to that scene. But instead of using conventional 'hard' matte technique—solid blacks and clear whites—we were able to create controlled-density mattes. That is, we produced a number of records which continually change in density across them and then build up images with anything from 15 to 30 or 40 passes through the printer. I think our biggest optical was 47 passes in one shot."

Use of graduated-density mattes enabled Ferren's staff to exercise a great degree of control over the climactic transformations at the end of the film. "For example," explains Ferren, "when we have a gaseous envelope of heat coming off a person and when their hand gets near a wall, that part of the wall has to glow with the reflected light. Also, the graduated-density mattes enable us to control the relationship of intensities when the arm is seen



Jessup's first hallucination sequence involved quite a number visually interesting full size sets. Both Ken Russell and Bran Ferren agreed that whenever possible effects would be filmed live before the cameras on stage, rather than relying on post production optical techniques.



Jessup inside the tank before metamorphosis.



Jessup inside the tank after and during metamorphosis. Dick Smith had to develop new techniques to handle full body suits in water.

against a black background, as opposed to when it is seen against the glowing body, or when we are looking lengthwise down the arm as opposed to crosswise—all those little relationships which one would rather not have to think about, but which are absolutely necessary.

"For some shots, Dick Smith built us a special body suit which fits Blair Brown so that you can see the muscle structure, etc. We painted onto that Scotchlite retro-reflective material and composite front-projected, while the scene was being shot, reference images and target marks. These keys gave us dynamically and spatially-oriented reference marks so that we could do a convincing job of matte work. A lot of the film's success is dependent upon very careful development and cooperation between multiple departments, between Dick Smith doing this and the cameraman doing that—none of the elements by themselves work, but when you put them

all together, then you end up with what you want . . . maybe.

"I think I have succeeded when you look at Blair Brown in the corridor at the end and it is not immediately obvious what is happening or how it is being done . . . I hope."

Fooling the Sophisticate

It is one thing, Ferren believes, to be matting in skylines and spaceships, but quite another to be working with people and real environments. "The average viewer is starting to get much sharper and more critical about this sort of thing with the constant barrage of SFX films in the past few years. I am sure that the obvious things will be noticed to a certain extent. For instance, there's Blair sitting there with a glow around her . . . okay, the glow had to come from somewhere, the image on the suit had to come from somewhere, but what I'm hoping for is that the person will say, 'There's a

girl in a clever costume sitting on the floor with a glow all around her.' But of course, the girl wasn't sitting on the floor, in that room, in that position.

"When you see this creature with this dark red suit, with highlights shining off it and other things reflecting around the room . . . that wasn't the dark red suit with highlights reflecting around the room, it was a normal person standing there, or it was a person standing there with body makeup on a suit to change the physical geometry of the human form; and then, from that point on, everything about the color and its structure and movement, etc. was reassembled!

"I think we got away with quite a lot of that."

The modern trend for increasingly complex images and special effects has led some producers and directors to think in terms of techniques and hardware rather than in terms of what they are trying to get



Jessup begins one of his hallucinatory "trips."

onto film. "It seems," Ferren comments, "that people want to use computers, or want to use lasers or want to use small nuclear devices to accomplish a given shot and often it is not the most expeditious way to get it done."

"Most things in effects are quite straightforward. There is a small percentage that has to do with brilliance, inspiration and clever ideas, but most of it is just, 'Well, we need to see this.' At which point you'll say, 'Would you rather see this instead?' Giving yourself a little artistic and editorial input into the situation, or you may say, 'Shall we do this another way?' Finally you come to a point of resolution and then it's just a matter of mechanically translating that to a piece of film."

"It's very rare that you are asked to do something that just cannot be done. More often than not you can't afford to do it, but occasionally something will come up which is outside the realm of all available tech-

nologies to achieve. That doesn't mean that you can't produce an acceptable image by using some other technique."

Too Close to Be Objective

"With *Altered States*, I've enjoyed being able to experience all three phases of production—from design to production to post-production. Each phase has its own particular set of challenges. In the actual production the major problem is *time*. Keeping a major production on schedule or anywhere near it, when you have six to nine sound stages and first, second and third units all working, is very demanding on a 23½ hour a day basis when it lasts for several weeks running."

"And then not to leave, after those weeks, but to be involved in the editing, sound mixing, further storyline development... it's very hard to pull back and be objective about things. When there is a change in the story, you have all of the accumulated experience of

what the first eight concepts were, you've seen every foot of film that was shot and you know every take that's in or out. It's very hard to pull back and say, 'Yes, this is definitely perfect.'

"It's a bit of a strange feeling to lose that level of objectivity. You don't lose it as much in the theatre, even though you're involved in some of the same procedures; it's over a shorter span—not like the year-and-a-half I spent on *Altered States*. Also, in theatre you have the advantage that once it's over with, it's done—it doesn't follow you around."

"The theatre is wonderful because it is so impermanent. It's this magical moment that happens in a slice of time and if you missed it you missed it. If you never saw *this* production of *that* play with *this* wonderful person in it, that is never going to happen again. And, in fact, that one performance, that one evening will never happen again. You are privileged to see, potentially, a very special moment. Also, if

you've been able to move the audience at all, then the flaws will tend to fade away and the audience will remember just what's wonderful with it.

"Film, however, has the advantage and simultaneous disadvantage of permanence. You can work film into shape, look at it whenever you want to and it's always the same. But later on, if you decide you don't like something, you're stuck with it and its *death* because the thing will follow you around forever and all of the flaws will jump out at you every time you see it."

Artistic Goals

In the field of special effects Bran Ferren is something of an oddity and a rarity. He has an artistic background and, yet, moves easily through the worlds of science and technology. Oftentimes artists are convinced that he is a technician and the technicians are convinced he is an artist. His personal joy is in the blending of the two worlds. He dropped out of high school ("Actually I just didn't go enough to graduate.") and restlessly dropped out of M.I.T.

"I met some interesting people at M.I.T., one or two of which work for me at the moment, and I had a nice research grant and my own lab. But I wasn't accomplishing anything particularly relevant and it occur-



Blair Brown shields her eyes from the blinding energy radiated from Jessup's isolation tank.

red to me that I was paying to do the sort of things that I could be doing on my own. I guess I should have been sitting down and learning how to be a *something*, but that concept has never been all that appealing.

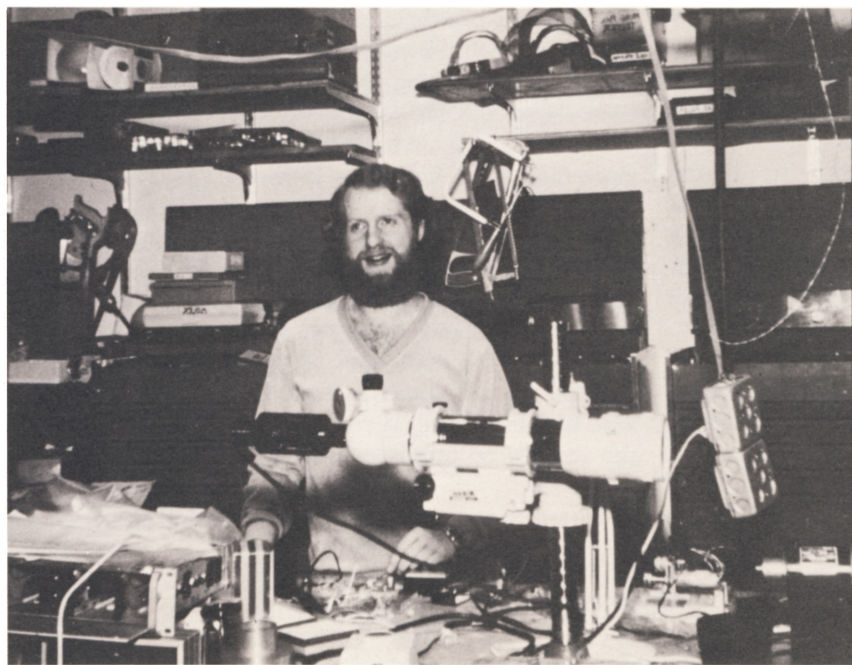
"I worked on a lot of miscellaneous things in those years, TV commercials, still photography, rock concerts; I worked at the Elec-

tric Circus. I found solving problems interesting and challenging, but not fully satisfying on an artistic level until *Altered States*, because my work has been such a tiny component of an immense undertaking. I could say, 'Look at the nice steady image of an elephant running down a ramp on roller skates!' There just had to be something more than that!"

Altered States has given Ferren just that sort of challenge. The cosmic transformations and images are immense challenges to both the artist and the technician. John Lilly, upon whose isolation tank experiments much of the film is based, set the starting point in describing some of his images:

"I moved into universes containing beings much larger than myself," he wrote. "The first time I entered these spaces, I was swept, pushed, carried, whirled and in general beat around by processes which I could not understand, processes of immense energy, of fantastic light and of terrifying power."

It was the goal of the *Altered States* production staff and special effects team to let the audience see it for themselves.



Bran Ferren in his Long Island workshop takes great pleasure in effects work for stage and screen.

Show SCAN

Hi-Tech For Tomorrow

I am frustrated with the way motion pictures are made and presented," says Douglas Trumbull. "So I've been sort of hiding out for the past few years, making some breakthroughs that I think are going to be received with great enthusiasm." The breakthroughs have come as a result of basic research he has been doing at his company, Future General, which is allied with Paramount Pictures.

"Except for Cinerama," says Trumbull, "no one has ever created a new film process that was clearly and distinctly separate from the rest and therefore worth the special effort. Is four-track magnetic better than an optical track? Is 70mm better than 35mm? Does it show up in the box office? Is it going to make or break people's decision to come to the theater? Ordinarily, it doesn't. And the producers know that, so they don't feel economically justified to go to the trouble.

"A big problem that occurred in the movie industry in the past was that the exhibitor has been isolated from the movie-maker by the anti-trust laws, which really crippled the whole possibility for the motion picture industry to move ahead in terms of new processes, wider screens, different kinds of sound systems, and all kinds of really dramatic improvements in

the medium itself."

However, at Future General, Trumbull has been working on a film and a new technique. The film is called *Brainstorm* and the process is called Showscan. About *Brainstorm*, Mr. Trumbull will only say that it is about the frontiers of the human mind and that a portion of it will be shot in January as a test. About Showscan: "It's going to be the ultimate experience—the highest conceivable quality."

At Future General, Doug has a five-minute test reel and demonstration theater set up. The reaction of those who have seen it is usually amazement and wonder. Steven Spielberg commented "...it's really remarkable. It's like looking through window glass—that's how clear the film is. You expect a breeze to come through the screen and blow your hair. It's the most amazing thing I have ever seen—even though, technically, I'm very conscious about these things. It's more than just a film; it's a very sensual experience."

Showscan is a 70mm film process. A high speed film process with the camera running at 60 frames per second, the projector running at 60 frames per second, special multi-channel sound, giant screen, new kind of lamp house. It requires that the theater be totally converted—a

whole new sound system, sometimes a reorientation of the seats. The screen occupies a large proportion of your field of view—more than Cinerama—and is slightly curved, though not as deeply as Cinerama. The result of the process is super-realistic.

Realism. That's the quest of Showscan. "When I began this project I wanted to know what creates realism and dimensionality in a motion picture and how those qualities could be improved." Television has a quality of aliveness to it that is lacking in film. "If one could take this quality of live TV and combine it with the resolution and color saturation with 70mm film . . . well, you've got yourself one hell of a movie."

It has been and still is a long term project to make what Douglas Trumbull hopes will be a quantum leap in motion picture technique. "Long term



PHOTO: DAVID HUTCHISON

Left: Douglas Trumbull behind the camera creating the startling effects for *CE3K*. Above: His Cineride system makes use of the Showscan process and surround sound.



not only in the conversion of my studio equipment (I took on *Close Encounters* to get hold of the necessary 70mm cameras, editing systems, and optical printers) but to make a first film. I think that *Brainstorm* will be a very unusual film not only for its Showscan format but for its content—it should be a mindbender."

The problem is theater conversion. "Theaters all over the world will be asked to convert at pretty considerable cost just to be able to exhibit *Brainstorm*; beyond that we must be able to guarantee to the theaters that there are more films coming their way. It's a monumental long-term commitment."

The conversions will take many steps. First there is the projection system: 70mm at 60 frames per second. Why 60 frames?

In an effort to improve the illusion of reality, Trumbull studied a number of existing systems, such as 3-D, which has never made it as a major

PHOTO: © 1977 COLUMBIA PICTURES

process. Why? Doug thinks, after studying the systems and making a few test films, that there is no future in 3-D films as they are made now and viewed with Polaroid glasses, because eyestrain is intrinsic in the process. In projection, the stereo image is causing your eyes to converge and diverge just as they do in real life. But in real life, the focus point is coincident with the convergence point. This is not the case with 3-D projection. In the theater your eyes always remain focused at the plane of the screen, while the convergence point moves back and forth—the result: eyestrain, or musculature discomfort.

3-D films still didn't look real, they just looked 3-D; which is fun, but it wasn't what Trumbull was after. He realized that movies were being made at the lowest possible number of frames per second.

A motion picture is usually defined as an assemblage of still photographs viewed in rapid succession. The property of persistence of vision makes one image flow into another so that the illusion of movement is maintained. According to Douglas Trumbull, "the way movies are made at twenty-four frames a second, or home movies at sixteen or eighteen frames a second, is right at the threshold of human acceptability. Fewer frames per second or fewer flickers of light per second will break down the illusion of motion.

"I wanted to know the *maximum* number of frames per second that the human mind could assimilate. The current practice in movie exhibition is to project at 24 frames per second; that is 24 fields of information per second. However, in order to compensate for the flicker of light that would be perceivable on a big screen, each frame is shown twice, so that the flicker rate is 48 flashes per second and therefore is much less noticeable to the human eye.

But, it turns out, the eye is capable of handling much more than 24 frames a second. "The real world doesn't exist as a series of still photographs; it's a continuum of motion and information. It's amazing how much the human eye sees and can observe in a short span of time."

It is the disparity between what the human eye is capable of and current standards of photography and projection that hampers the illusion of reality in motion pictures.

To test various frame rates, Trumbull projected films made at high-speed rates and those made at the standard twenty-four. He wanted to establish a relationship between the viewer's physiological response to something his mind perceived as real with motion pictures made at various frame rates. A number of UCLA students were used as guinea pigs and their EEG's monitored to measure their responses. Analysis of the

charts showed the physiological response to something that the mind believes is real *increased fivefold* when the frame rate approached 60 per second.

The projector modifications are considerable. In addition to the increased frame rate, the lamp housing has been redesigned to increase screen illumination several times. There will be no reel changing for a 90-minute feature. The film will lie on a platter wound on a core. The platter filled with film will be about eight feet in diameter and weigh about one ton. That's a lot of film. But the system doesn't use up as much film as the wall-sized I-max 70mm system at the Air & Space Museum at Washington's Smithsonian. The I-max uses three times the frame area of normal 70mm. The I-max is also plagued with flicker problems due to its immense screen and strobing problems involving the twenty-four-frame-per-second format. "You have to be very careful how you move and pan the camera, since images can jump six feet during a pan on that enormous screen."

Showscon, with its new cameras, projectors, and screen size will also have to make use of a new sound system to deliver what Trumbull believes will be "the ultimate motion picture experience."

The new sound system, which still has a number of patents pending, will be a six-channel system. But each channel is broken down into four distinct frequency bands and separately amplified and fed to speakers designed for that frequency band. The theory being that a more efficient, low distortion amplifier can be built more economically if it just has to handle a portion of the audio frequency range. Also, the amplifiers will be high powered to allow full dynamic range for the audio signal without distortion. The sub-woofer (deep bass) is a horn with a frontal opening of eighty-five square feet! This, plus the midrange and tweeters, are multiplied by the six channels into a sound system that should leave Sensurround in the dust. Douglas Trumbull expects to have a sound delivery throughout the entire acoustic range that is second to none. In addition to the realism of a clearer, brighter, sharper, more detailed,



James Shourt and Doug Trumbull are shown designing possible configurations of truncated tetrahedrons.

PHOTOS: COURTESY AMERICAN CINEMATOGRAPHER



Trumbull made his directing debut with *Silent Running*. The film is noteworthy for its visual poetry and interesting story.

Shows-can image, he hopes that the sound system will create a psycho-acoustic environment for the audience.

Each theater will have to be individually tuned to the sound system. Engineers will analyze the theaters with modern, sophisticated, real-time spectrum analyzers and graphic equalizers to tune all the peaks and valleys out of the acoustic response of the theater. "We have developed electronic monitoring devices that will measure the amount of acoustic absorption by the audience (determined by how many are present and what they are wearing) and automatically adjust to the levels of the various channels and amplifiers.

"To achieve a psycho-acoustic illusion we will be constantly monitoring the quality of the sound in the theater. By experience, the human ear learns that certain qualities of sound signify different shapes and sizes of rooms.

"Certain kinds of environment generate a particular quality of sound and vice versa." To a limited extent this is done today when the sound track is being mixed down by the editor. "We intend to go beyond that to heighten the illusion of reality. Our systems will monitor and create the sound effects in the theater.

"What goes on in most theaters today is the worst, so that any improvement like Dolby, or Sensurround is worth having."

Steven Spielberg says: "My pet peeve is that theater managers and exhibitors for decades have refused

to update their systems. We bust our asses trying to give you terrific sound, and they play it back through what looks like stereo speakers in your car—fifty years old. There are only about 200 theaters capable of giving good quality sound. The other 1500 or so are still back in the 'Vitaphone' Jazz Singer days."

Douglas Trumbull hopes to change all that.

The screen size will be interesting—current plans call for a screen 50 feet high and 110 to 125 feet wide depending on the aspect ratio (that is, the width of the film frame in relationship to its height).

"Paramount plans to convert a theater in the Los Angeles area this year to run my test film. The idea is to test the Showcase with a live audience, get their reaction, and gain an idea of the marketability of the system—will movie-goers pay to see films in Shows-can. Will the return be worth the investment?

There are other applications, however, for the Shows-can process. An interest in the amusement park business has been in the back of Trumbull's brain for some time. Theme parks such as Disneyland and Walt Disneyworld have made extensive use of "dark rides." The Haunted House in Disneyland is an excellent example. Disney makes use, of course, of their audio-animatronic robots to create an illusion of reality with people, animals and places. Perhaps the greatest of these is "Pirates of the Caribbean" in which spectators move in small boats through underground caverns passing various scenes of pirates in action. It's quite thrilling and great fun. It does, however, take up a great deal of space, requires skilled maintenance and is expensive to build.

Douglas Trumbull's Cineride would make use of the Shows-can film system to heighten the illusion of reality. The small car or boat would pass through areas, such as a haunted house, in which most of the wall space would be taken up by a rear projected Shows-can image.

In principle, other than the extreme quality of the Shows-can image, film in dark rides is nothing new. But again Douglas Trumbull has invented

a new method for the filming that achieves the illusion of three-dimensional perspective.

As the car moves past an ordinary rear-projected image, even a Shows-can image, there is no change in the perspective. As the viewer travels along at a foot per second, it's like driving past an animated billboard. Flat. But if the original scene is filmed with the camera moving along a motorized track at one foot per second and panning in the same motion that the viewers' heads would turn while the car moved, then the image seems to have real depth and reality becomes very difficult to separate from illusion. The system has the advantage of being able to use human actors instead of being limited to intricate and costly robot machinery.

Though Shows-can and Cineride are still in their developmental stages, their impact could be revolutionary in the history of the motion picture and its applications. It is no wonder these new processes are making special effects artists into box office stars. In the future we may expect



Trumbull directs Bruce Dern on the set of *Silent Running*. Many of the interiors were filmed aboard the old US Navy aircraft carrier *Valley Forge*.

to see fans flocking to see films from the workshops of the new heroes of the imagination. Where once people stood in line to see Gable or Monroe, lines will soon be forming to see films by John Dykstra, Ray Harryhausen, Doug Trumbull or any of a dozen of other great special effects artists.

Trumbull sees no reason not to expect that, like the stars of the golden era, special effects artists will soon have their names above the titles. ●

STEREOSPACE

It's happened before in cycles—approximately every twenty years. Right now, it's on the upswing again, but it's different this time; the cycles may be over—it may be with us for good.

What is "it?" Well, this time the cycle isn't sun spots or locusts or flying saucer reports, but something much more entertaining—the public's interest in 3-D movies. The last big surge came in the early 50s. Before that it was the middle 30s; before that it was the late teens and early 20s. And, of course, the very first 3-D movie was made in 1889 by William Friese-Green in England.

Interest began growing slowly in the late 70s and is very much with us in the late 80s. Movie theaters in major cities have been screening 3-D greats and not so-greats from the 50s to S.R.O. houses. Cable TV systems have been broadcasting some of the same features to their television subscribers. Anaglyph versions of classic 3-D horror and SF films are available in Super-8 and on videotape for home viewing. Interest in amateur stereo photography has been growing steadily despite the lack of modern stereo equipment. So it is not really any great surprise that a number of companies have surfaced with modern 3-D motion picture systems.

There are two main approaches to 3-D filming in the United States. The

single camera dual image system, which places the left and right images either side by side or stacked one above the other on the same strip of film, and the dual camera system which utilizes two interlocked cameras to record the left and right images on separate strips of film.

These systems are available in all film formats from Super-8 to 70mm. While, most of the film industry remains very cautious with 3-D and has adopted a "let somebody else do the trailblazing" attitude, United Artists Theatre Circuit, Inc. has invested in a dual camera 70mm system which has the potential to raise the quality of 3-D film going to unheard of heights.

Spokesman Richard Vetter explains what led the U.A.T.C. into 3-D. "U-A has a lot of large movie theaters in this country, theaters on the scale

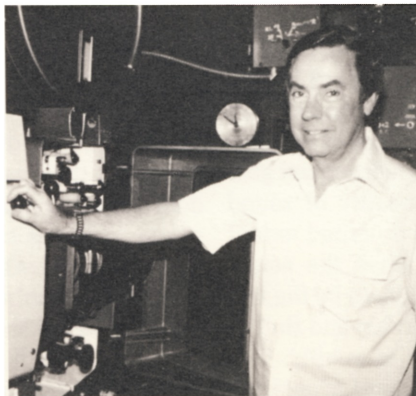


PHOTO: DAVID HUTCHISON

Richard Vetter pauses beside one of the 70mm projectors used by StereoSpace.

of the Rivoli in New York and the Egyptian in Los Angeles. There are 40 or 50 of these large flagship theaters that are so large that it takes a movie 'event' to do a pretty good business. They need films that run for months to good crowds. The Egyptian Theater here in Los Angeles did a terrific business with *The Empire Strikes Back*. These big theaters do very well if you have an 'event' and do not do well with an ordinary feature because the operating costs are too great.

"So that's what led us to 3D."

Today the era of widescreens, Dolby sound and 70mm projection is very much with us. "Back in the 1950s, 3D never went into the big theaters with big screens," Vetter points out. "The systems of the time had a number of problems, but very little time or money was spent by the major studios to develop a 'proper' system. Generally, a system was breadboarded together very quickly and a few hundred thousand dollars was spent to make an exploitation film. There were a few notable exceptions, such as *House of Wax*, in which they came close to really using 3D.

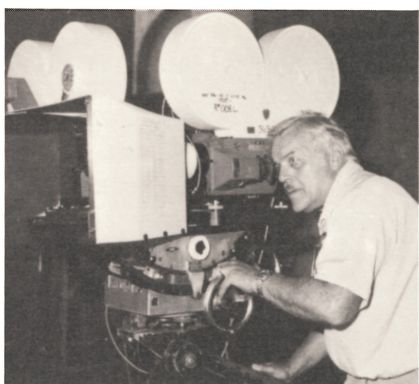
"We decided that if we can't do it better than they did in the 50s and 60s then we don't want to get into it. I think the first weakness to overcome was insufficient light for projection. When Polaroid filters were placed over the projection lens and the audience donned their Polaroid glasses, the net loss with the combination of these two sets of filters was about two-thirds of your projection light. On a small screen this is not so much of a problem, but when you get into a big theater with a 35-foot screen or larger, your audience will be sitting there for 90 minutes looking at a picture that's badly underlit and you are going to have eyestrain.

"Other problems can be traced to the 3D photography. Few people understood how to make the camera see the same way the audience in the theater sees. Through a lack of understanding scenes were photographed in such a way as to cause eyestrain for the average theater goer."

Vetter explains how StereoSpace has made use of modern technology to overcome these problems. "StereoSpace uses twin 65mm cameras for

the original 3D photography and twin 70mm projectors for theater projection. (The extra 5mm is used for the magnetic soundtrack.) Each projector has a big 4 kilowatt xenon projector lamp. Of course, the screen is metallic for stereo projection so it has a gain factor of close to 3 times what a matte screen would have. The 70mm aperture on the projector passes a lot of light, so we have no trouble maintaining 16 foot-Lamberts of brightness measured through the viewing glasses. (Sixteen foot-Lamberts is the S.M.P.T.E. standard for screen brightness) StereoSpace can accommodate screens up to 65 feet without any difficulty.

"The other factor in our favor is image quality and definition. Since we are using two 65mm cameras, we are



Cinematographer Barry Gordon on location in Egypt with the StereoSpace cameras.

using five times the amount of film used in standard 35mm photography—which buys us incredible definition. For example, there is a shot on our demo reel in which you are more than a mile away from the pyramids in Egypt... and you can almost count the stones.

"Even more important, cinematographer Barry Gordon and myself have done nothing for years but study 3D. We've had a number of consulting oculists and ophthalmologists working with us to come up with a camera system which allows the audience in the theater to see in 3D the way you would normally view something in real life. You can look comfortably from foreground to background as if you were actually there."

Vetter emphasizes that in projection the infinity points of the left and right eye images are kept 2½ inches apart. Our eyes are approximately

2½ inches apart, and therefore your eyes are looking straight ahead, parallel, when gazing at infinity. This condition is matched in the theater with StereoSpace.

A news system has been developed to keep the twin projectors in perfect synchronization. Even a single frame out of synch can be irritating. StereoSpace uses one set of the magnetic tracks for digital synchronization. Even if the projectionist mis-threads the beginning of the reels, the system will automatically pull itself back into synch.

The camera system consists of a pair of 65mm Mitchells mounted at right angles. The interaxial distance between the two cameras is accomplished through a beam splitter and can range from 0 to 4 inches. The flexibility allows for hyper and hypostereo effects.

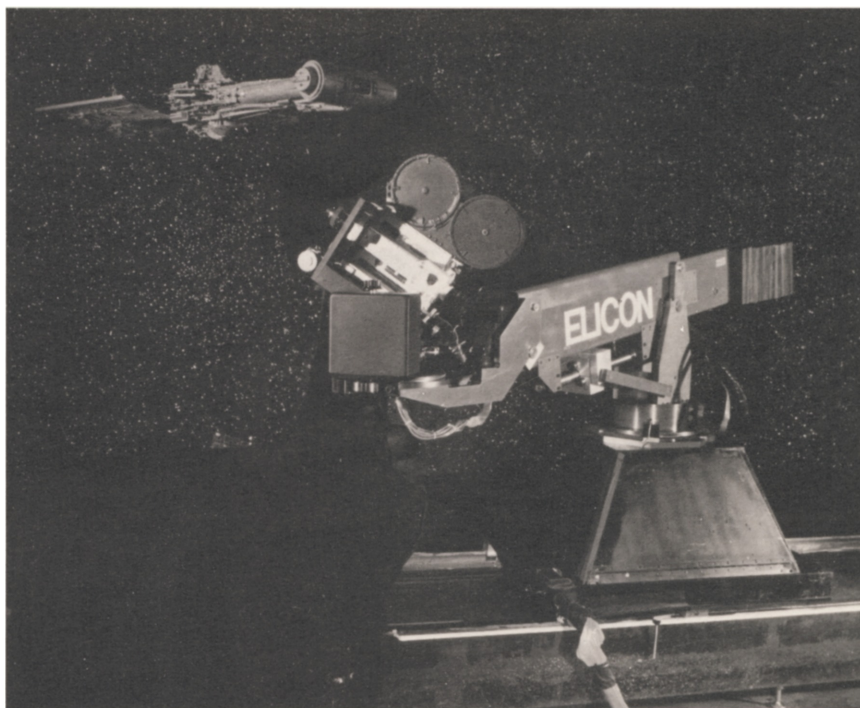
For those that have never seen a 3D film, StereoSpace promises to be a very thrilling experience. In regular 2D flat movies a close-up shot means the image gets larger on the screen. In 3D it means the image comes closer to you. The system has already been leased by Walt Disney Productions and Kodak for use in the Imagination pavilion at EPCOT. But its real future lies in saving those big screen movie houses that have not yet been converted to "quads" or "triplexes."

Vetter is very definite about his dislike for modern single strip 35mm processes such as Spacevision which use the small Techniscope format. "The over-and-under single strip 35mm system is much too small for large screen presentation. A 30 foot screen stretches the format to its limit. Our system has seven times the brightness, clarity and definition."

The soundsystem for StereoSpace is designed to reproduce sound which matches the 3-D images in space. The Dolby multi-channel magnetic sound system will create as much an aural illusion of reality as the visual 3D image.

United Artists Theatre Circuit is looking for exactly the right property to showcase their system including science fiction, horror or even a modern fantasia. If the right property is found 3-D may finally be here to stay. ●

Elicon



There is no better example of the rapid progress in special effects technology than the current proliferation of computer controlled camera systems in Hollywood and New York. Today's inexpensive microprocessor circuitry has placed advanced technology within the grasp of low budget filmmakers. Though some production houses have preferred to build and design their own equipment (Lucasfilm, Disney) other houses have sought sources from the outside. Amazingly the demand for the equipment is such that a few companies have sprung up which specialize in the

design and manufacture of the equipment for special effects houses. In the past, a studio or special effects house hired experts away from other industries (manufacturing or aerospace) to design and build custom equipment. Nowadays, you can practically buy it off the shelf. One of these suppliers is Elicon.

The Elicon Camera Control System (CCS) provides the filmmaker with an advanced, repeat pass miniature and graphics filming system. The CCS is a multi-axis camera motion control system, utilizing a Digital Equipment Corp. PDP-11 minicomputer and state

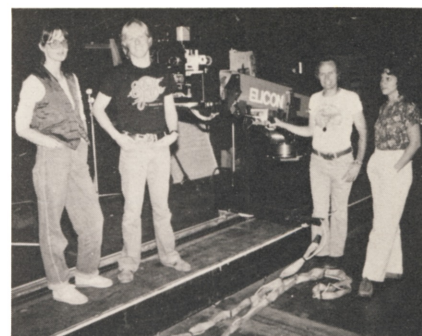
of the art servo technology developed by Elicon. The system is in use at a number of production houses among them Roger Corman's New World Pictures and Bob Kiger's Videography. Already the system has found use in such features as *Battle Beyond the Stars*, *Escape From New York* and *Georgia Peaches*; the modern space age look of television commercials has also capitalized on the flexibility and availability of the Elicon CCS.

The CCS looks like many other camera systems in principal. It uses a horizontal track and a boom arm. The camera pans, tilts, moves forwards and backwards along the track. Additionally, the camera is capable of moving in an arc across the track as

well as vertically above the track.

The closed-loop DC servo drive developed by Elicon provides smoother and more accurate positioning than the stepper motor drives of some other systems. The camera moves can be programmed by a variety of techniques. The camera can be physically pushed along the desired path of motion with the path being recorded by the computer, or the camera can be controlled by a joystick.

Further, the data files can be modified or created on a point by point basis, or points may be defined and a smooth curve motion generated to fit the points. A number of acceleration modes are possible on any given move so that the camera can "ease-into or



Elicon's installation at New World.

out" of any given move. The programming allows camera motion to be defined or modified using mathematical formulas. There is a "point of interest" program so that a specific target either stationary or in motion will be automatically tracked by the camera.

Finally, after recording the moves for a model motion shot, the CCS program will compute the camera positions for a graphics pass. This function allows for the addition of a two dimensional graphic (such as a starfield) to a three dimensional shot while still maintaining the perspective essential for realism.

The standard software package allows you to film live action in real time or time exposure photography down to 85 seconds per frame. Streak, stop-action, simulated shutter, slitscan and smear effects are all standard.

The CCS includes the Elicon Follow Focus System which operates with most standard lenses. The Follow Focus System is used on optical printers and animation stands to automatically hold focus during zooms. On the CCS a wide variety of lenses can be used. The operator merely enters the focal length of the particular lens into the computer. The follow focus also provides the exposure corrections required for close-up photography. The plane of focus on a model or graphic can be programmed to move from one point to another during repeat pass photography.

As a further touch in Elicon's comprehensive approach the CCS is also available in a vertical animation stand version for the ultimate in cel animation. The animation system is currently being used by the adventurous Nelvana, Ltd. group whose animation has been so well received in this country in recent years. ●

Specifications

Typical Boom Arm Configuration

Servo axes	Accuracy	Range
Camera Pan	1.0 arc minutes	± 720 degrees
Camera Tilt	1.0 arc minutes	± 90 degrees
Boom azimuth	1.0 arc minutes	± 720 degrees
Boom elevation	1.0 arc minutes	± 60 degrees
Camera track	0.002 inch	40 feet
Camera focus extension	0.001 inch	2 inch
Camera motor	0.005 frame	5000 frame

Synthetic axes

Camera viewpoint pan	0.03 arc minutes	360 degrees
Camera viewpoint tilt	0.03 arc minutes	360 degrees
Camera viewpoint NS	0.001 inch	80 feet
Camera viewpoint EW	0.001 inch	80 feet
Camera viewpoint vert	0.001 inch	80 feet
Target NS	0.001 inch	80 feet
Target EW	0.001 inch	80 feet
Target vertical	0.001 inch	80 feet

Standard Features

Camera mount	35 mm Mitchell HS
Max frame rate	20 FPS (higher speeds optional)
DC servo control	Provides accurate and smooth motion
Follow Focus	Maintains focus through 1:1
Joystick dynamics	Provides smooth joystick moves

Optional Features

Graphics	Real time plot package for Tektronix 4010 CRT
Model mover	For miniature photography
Digital I/O	For control of lights etc.
Extra servo axes	For spares, special setups etc.

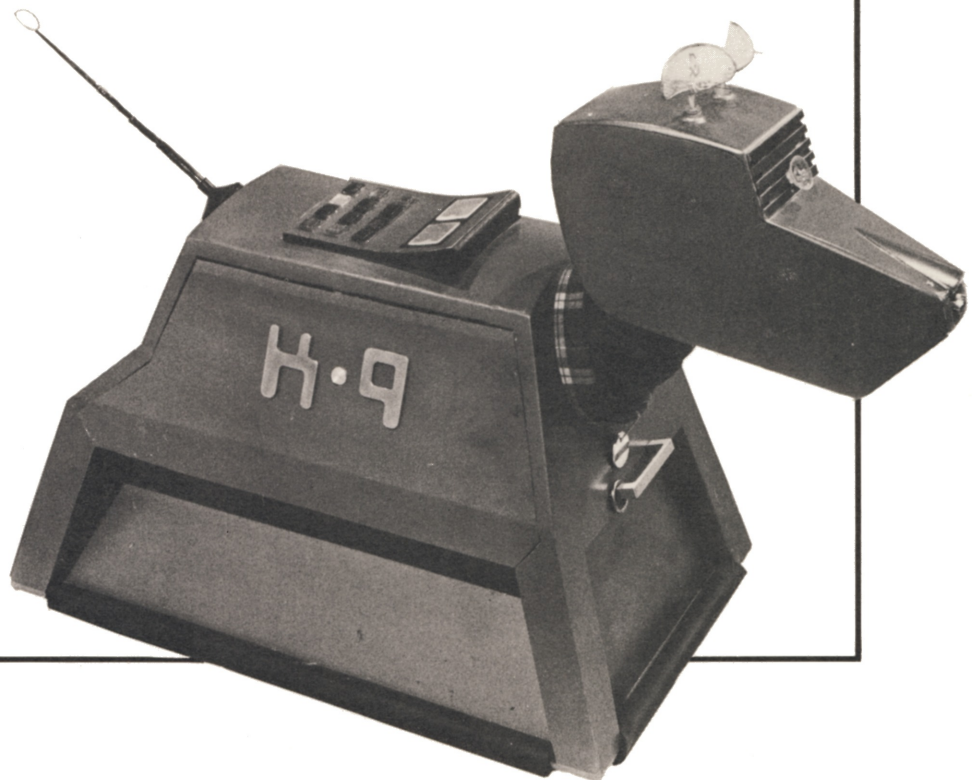
LETTER FROM ENGLAND, II

Ever since issue #23 when STARLOG 'discovered' *Dr. Who*, and I myself formed part of the article, I'm glad to see that the programme gets a mention now and again in your pages.

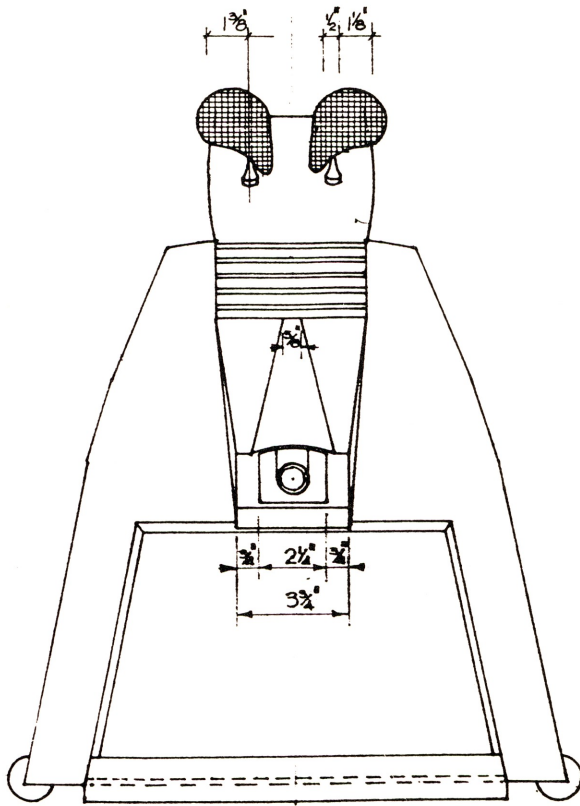
I know short articles have to gloss over details, but I do feel that our favourite pet deserves slightly more than the piece in issue #38. So as I work within the BBC department that actually built K.9, perhaps I can explain more about his 'works.'

To set the background, over the years the number of creatures, monsters and other personalities that

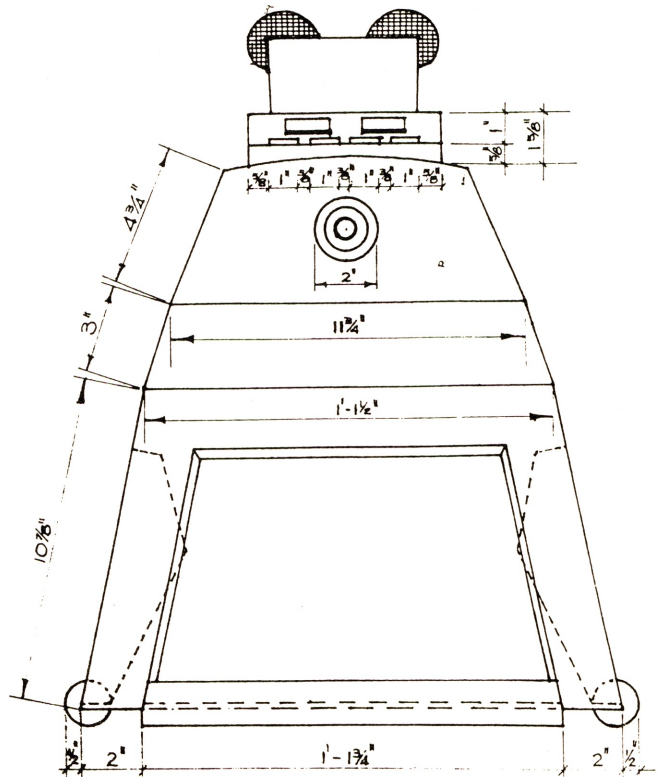
have been created for all the *Dr. Who* stories has been enormous, but one can never tell which, if any, will catch the public's imagination and become something more than yet another monster. The Daleks are probably the most famous and retained their popularity (or should it be notoriety) even during the years when no Dalek stories were produced. Cybermen, Ice Warriors and Sea Devils had a certain following and the last story that featured Jon Pertwee, also featured the Spiders, which were surprisingly popular. However as far as the latter is concerned I must admit to



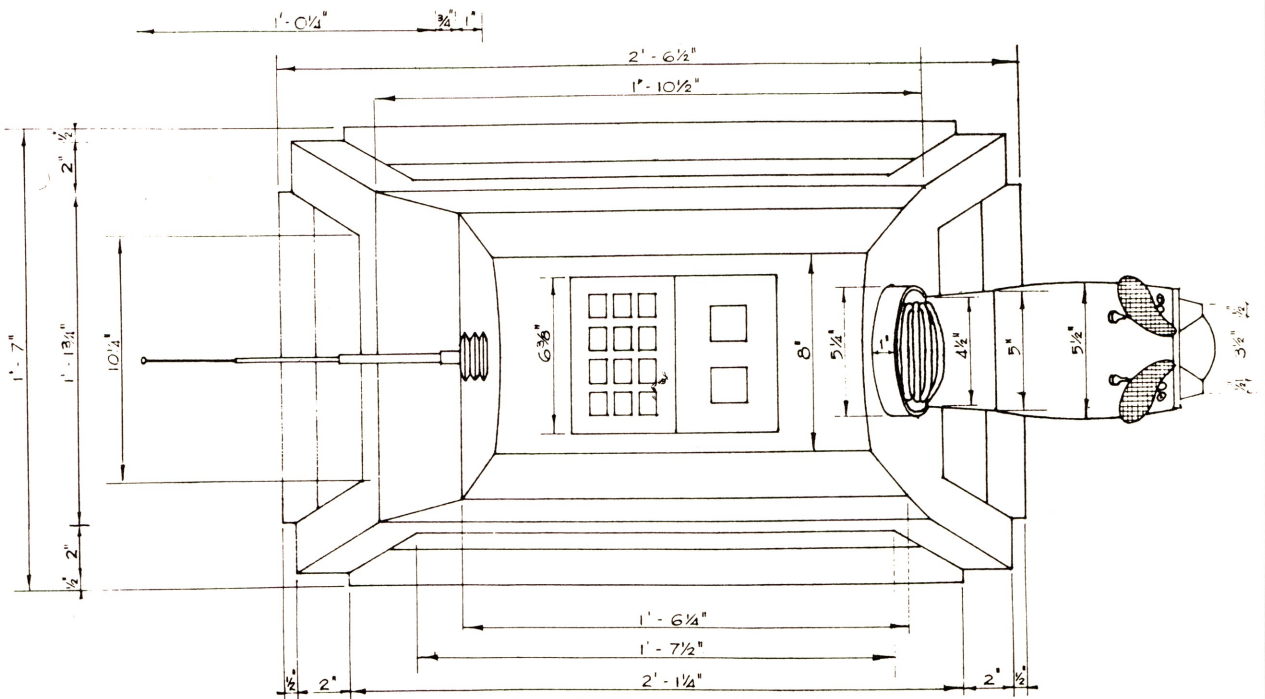
FRONT ELEVATION



REAR ELEVATION



PLAN



having continuously fostered this particular story as I originally made, and still have, one of the spiders, Boris, who is motorised and self-contained and is well known to the convention circuit in Britain.

As you correctly stated, K.9 was designed for the one story only, "The Invisible Enemy." Originally there was no plan for him to stay and consequently details that would have been nice to build into him could not be justified for the single story. Even so he took considerable effort to build within the time and my colleague, Tony Harding, who deserves the credit for the actual design, had many hectic days trying to co-ordinate everyone's effort in constructing the beast. Yes, the first effort wasn't all that sophisticated and, yes, he did have a chain drive which was quite noisy. To coincide with the Mk.2 K.9, (the Mk.1 was left with Leela), the opportunity was taken to change the motor and drive, and to re-spray him a slightly different colour. The belt drive that was fitted was much more efficient and did not in fact break that often! They were the same type of belts that are used in car timing systems, so it does indicate what sort of torque was involved. Besides this change, K.9's innards remained basically the same as the original, until at the start of this season.

It was decided that K.9 wasn't mobile enough for rough terrain when on location, although to be fair, remember he was only built to cope with the flat floor of a television studio. This is where the caterpillar tracks came in, although they were very much a prototype affair and quickly abandoned.

However, it was also becoming apparent that most of K.9's mechanics were wearing out and that he really needed a complete re-fit. I remember discussing the problem with another colleague, Charlie Lumm who had done a lot of work on K.9 and other electro-mechanical devices as to whether it was worth re-building him. We eventually decided 'yes' and so virtually all the mechanisms have been replaced for this season. Originally he was fitted with 10 channels of radio control gear, a 6 and 4 channel. Technically these were on the AM

The Doctor with Time Lady, Romana and companion K.9. K.9 was born in the story "The Invisible Enemy" but proved to be a popular companion for the Doctor. Inside word has it that K.9 can be bribed with battery-powered dog biscuits.

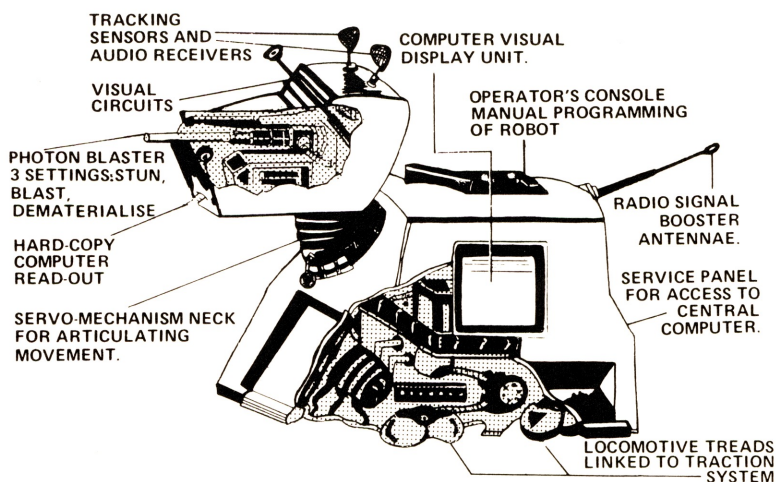


band which can be fairly prone to interference, although in practice they tended to give out more interference than receive, particularly to monitors and talk-back systems. But they too were nearing the end of their useful life and I decided to replace them with an FM system which is far less prone to interference, and in consequence

two 6 channel MacGregor JR series were bought.

One particularly annoying problem with the AM sets is that they would not work in close proximity to one another, even with crystals at opposite ends of the 27MHz band. The FM sets get around this and you can tuck both transmitters into the crook of one

K.9 CONTROL SYSTEMS



SIDE ELEVATION

Technical drawing showing the side elevation of a mechanical assembly. The drawing includes dimensions for the base, the main body, and the hinged lid.

Base Dimensions:

- Overall width: $2' - 1\frac{1}{4}"$
- Left side width: $2"$
- Right side width: $2\frac{1}{2}"$
- Front depth: $11\frac{1}{4}"$
- Internal width: $1' - 7\frac{3}{4}"$

Main Body Dimensions:

- Top width: $1' - 2\frac{3}{8}"$
- Top section widths: $2\frac{3}{8}"$, $8\frac{1}{2}"$, $3\frac{1}{2}"$
- Top section heights: $4\frac{1}{4}"$, $4\frac{1}{4}"$
- Top section depths: $3\frac{1}{4}"$, $3\frac{1}{4}"$, $3\frac{1}{4}"$, $3\frac{1}{4}"$, $3\frac{1}{4}"$
- Top section heights: $1\frac{1}{2}"$, $1\frac{1}{2}"$, $1\frac{1}{4}"$
- Top section width: $1' - 3\frac{1}{8}"$
- Top section depth: $6"$
- Top section height: $5"$
- Top section width: $4\frac{1}{4}"$

Lid Dimensions:

- Lid width: $8\frac{1}{4}"$
- Lid height: $6\frac{3}{8}"$
- Lid depth: $10\frac{1}{2}"$
- Lid width: $2\frac{3}{8}"$
- Lid height: $3\frac{1}{8}"$
- Lid width: $3\frac{1}{4}"$
- Lid height: $2\frac{3}{8}"$
- Lid width: $1\frac{1}{2}"$
- Lid height: $1\frac{1}{2}"$

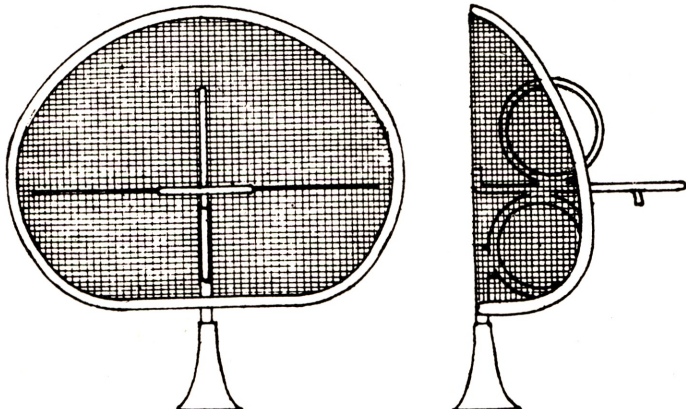
cadmium.

servos and his head is pivoted and counterbalanced and moved by a sail-wich servo.

He did have a simulated VDU screen in his side which was fitted with the blue colour used for what is normally termed Chromakey, but which the BBC still tend to call CSO (Colour Separation Overlay), but its the same system. This feature though has not really been exploited since the first story. Similarly the month does have a 'computer read-out' tape, but this function has not been used all that often and is in fact removed at present.

That, relatively briefly, is K.9. He can be fairly demanding to operate and usually we use a specific person, not attached to the Visual Effects Department, to control him. Recently however I've been running him myself, both in studios and functions outside where he is always in great demand. ●

K.9 ANTENNA



The image contains two technical drawings of a K.9 antenna. The left drawing is a top-down view of a circular antenna. It features a fine grid pattern across its face, with a central cross-shaped structure consisting of a vertical rod and a horizontal rod. The antenna is mounted on a flared base. The right drawing is a side view of the same antenna, showing its depth and internal components. It reveals a horizontal rod and a vertical rod, along with a small rectangular component on the right side. The antenna is also mounted on a flared base.

—Mat Irvine
Visual Effects Designer
November 4, 1980

Explosions For Miniatures

Effects Artist Joe Viskocil
Makes the Small Seem Large.

Joe Viskocil's carefully constructed explosions for the miniatures in *Flesh Gordon* made him known to the film industry. *Star Wars* gave him a showcase for his talents in what is essentially a new art in special effects. Joe Viskocil, an accomplished still photographer and film technician by training, has created his own niche in the film industry by developing a new and highly specialized art—miniature explosions.

The term *miniature* applied to an explosion might seem to be a contradiction in terms. But many of the concepts and story situations now following in *Star Wars*' vapor trails can only be realized by the use of miniatures—intergalactic battles, alien attacks etc. And where there are battles, there are explosions.

"I firmly believe that *anything* can be done in miniature," says Viskocil confidently. Certainly, recent films such as *CE3K* and his own work in *Star Wars* would seem to bear him out.

Miniatures, as a film technique, have been in use since the pioneers of cinema. Consider Melies' *A Trip to*

the Moon, made in 1902. Miniature explosions, however, have appeared only sporadically. "You would see a lot of miniature explosions in films like *This Island Earth* and *War of the Worlds* (which influenced me a lot) and I could study what they had done over at Universal. But otherwise, everybody else in Hollywood knew how to blow up cars and buildings, but nobody specialized in miniature explosions."

Explosions on a small scale have a number of problems in common with other "impossible" miniature effects. Water, for example (the *Logan's Run* cityscape) or fire (the flames in *When Worlds Collide*)—you can tell that they are miniatures.

"Once I came out of the theater having just watched *Chitty Chitty Bang Bang*. I overheard some of the kids talking about the 'blue line' around the car, that it looked odd, funny. When kids notice things like that, than you are in real trouble. I want to totally fool the audience. I want to make it look real.

"The moviegoing public is not stupid—they want to see quality—they

PHOTO © 1978 JOE VISKOCIL



PHOTO © 1978 UNIVERSAL

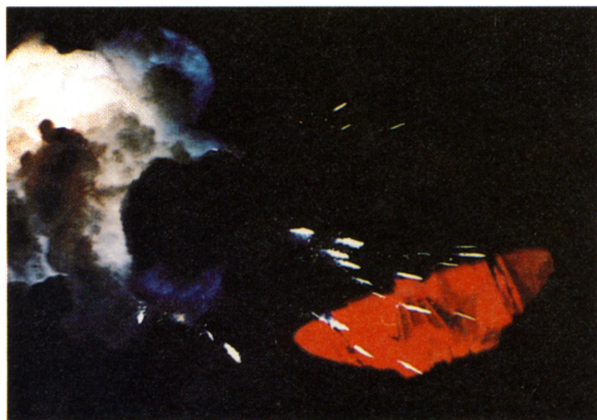


PHOTO © 1977 20TH CENTURY FOX



PHOTOS © 1977 20TH CENTURY FOX



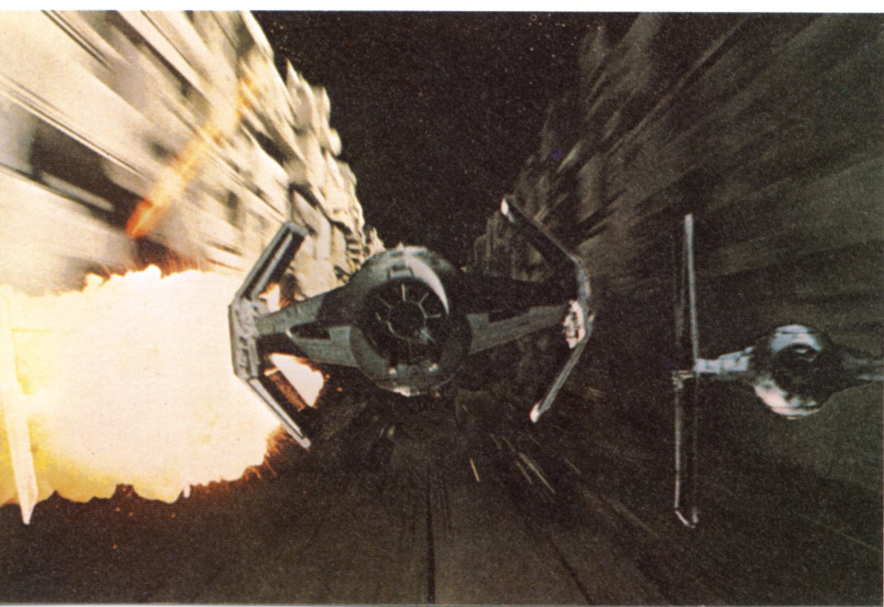
Above left: The first take of the tower explosion from *Flash Gordon*. The first take was the best—a good shape, flaming fragments and a cloud about three feet wide.

Above: A Y-wing breaks apart into points of light. This sort of explosion was rejected in favor of the more violent-looking billowing flames as in the frame blow-up at left. George Lucas had asked for a brief “aura” to appear around the ships just before they were blown apart.

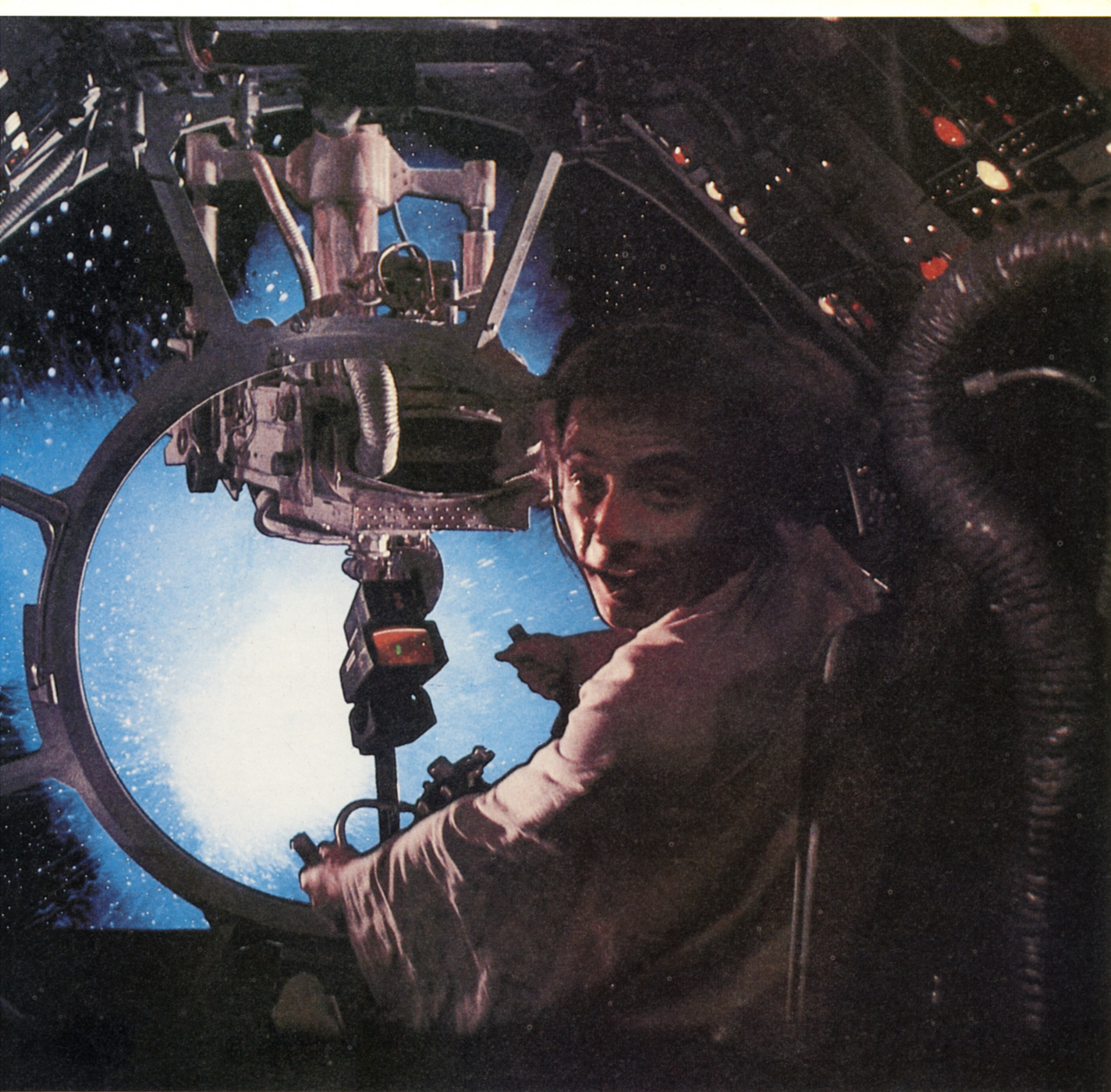
Left Middle: From *Battlestar Galactica*, faster and cloudier explosions were asked for with more of an “aura” effect.



PHOTOS. © 1977 20TH CENTURY FOX



Above left: Joe Viskocil demonstrates to Joe Johnston the correct method for rigging an X-wing for destruction. Two charges are rigged in the rear and one in the front of the model. The underside of the cockpit of the model was scored to break apart in a predictable manner. **Left:** The finished composite in the *Deathstar* trench. **Above:** Early test composite for the TIE fighter sequence. This test shot has not yet been color corrected to show off the green TIE explosions.



want to see it done right. There's always a challenge involved in making an explosion look big or small, whether the explosion is big or small—it could be a few inches or a few feet, but it's a matter of making it look good on the screen and *believable*—making it look believable is of the utmost essence."

One of the keys to believability is consistency. "I insisted upon some sort of continuity, some sort of design to the explosions themselves. So that if you see a ship blowing up, it will more or less look like the rest of the ships that are blowing up." In real life

the ships would have all been built with the same plan and would be using the same type of fuel, therefore their explosions should have the same sort of identity.

For example, in *Star Wars* all the TIE fighters exploded with a green flame and smoke with gold sparks. It is likely that most audience members were not consciously aware of this consistency, which is as it should be. It looked *right*. Audiences would have noticed it if it had looked wrong—ships breaking apart in different ways or in a rainbow of colors.

Another key factor to believability

is the choreography. In *War Of The Worlds* there is an excellent sequence of the Los Angeles City Hall being blasted by the Martian war machines. "They make it so that it was a two-layer explosion. The bottom layer would explode first, then the top. Then the middle of the entire diamond shape of the dome would come crashing down."

Or Tom Scherman's castle in *Flesh Gordon*. "I choreographed the castle destruction to make sure that it wouldn't go up all at the same time, which when you are working with a small and fragile model, is a very real

problem. The destruction had to be a step-by-step maneuver. I prepared the model by cutting up certain areas that I wanted to see flying apart. I wanted to actually see sections being destroyed. Usually you have to take a model and almost tear it apart from scratch so that it will come apart the way you want it to. When the explosion goes off you should see fragments of the model as debris flying through the air, some toward the camera and some spreading up into the air.

"I just finished a film called *Fire In The Sky*, which was made for NBC-TV. I did a number of explosions for the sequence which involves a collision of a comet with the city of Phoenix. Part of the sequence consisted of a mushroom-cloud explosion. I set a number of charges so that they would come toward the lens and one major one going straight up for the mushroom effect. It worked very well.

"Gerry Anerson usually had very well-choreographed explosions—

they looked like they took the time to break down the sets and place explosions where there should be explosions, in stead of just on an empty hill."

Placement of the explosive charge is essential to that all-important goal of complete believability. "There should always be some reason for the location of an explosion—how it starts and grows. Usually, with vehicles of any sort, you start with the fuel tanks (or whatever makes it go) and let the explosion grow from there."

But even with careful planning, storyboarding, design and construction, miniature explosions are not completely predictable. "No two explosions are going to come out the same, you can usually recreate the basic texture—the type of debris you want to see—but the exact form of the explosion after ignition is very unpredictable.

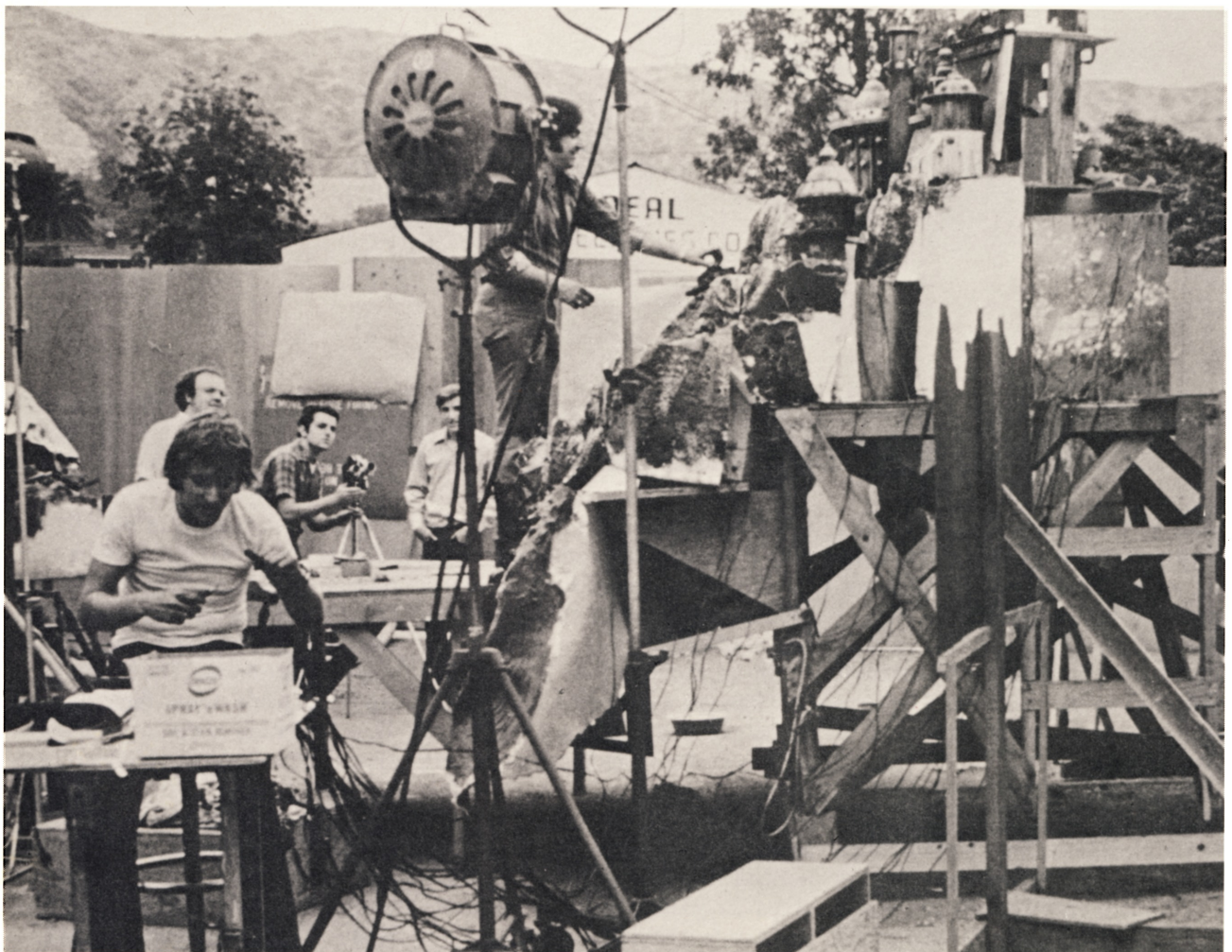
"You can control your results by

using certain chemicals for various colors and quantities of smoke and flame. Packing the bomb differently will result in either a soft explosion or a hard-and-fast one; and, of course, the quantity of material is a factor."

For these reasons, every pyrotechnician should keep good notes while he is experimenting. An accurate log will enable you to reproduce effects, not only for retakes, but when similar effects are called for on other projects months or years later.

Like most miniatures, miniature explosions must be filmed with a high-speed camera. Filming at high speed and projecting at the normal rate of 24 frames per second will make the particles of debris move more slowly across the screen. Most of the *Star Wars* explosions were shot at 100 frames per second. This camera speed gave just about the right scale of movement to the explosions for that particular size model.

"The *Deathstar* shot was one of the



Joe Viskocil at the controls for the destruction of the castle in *Flesh Gordon*.

PHOTO COURTESY JOE VISKOCIL

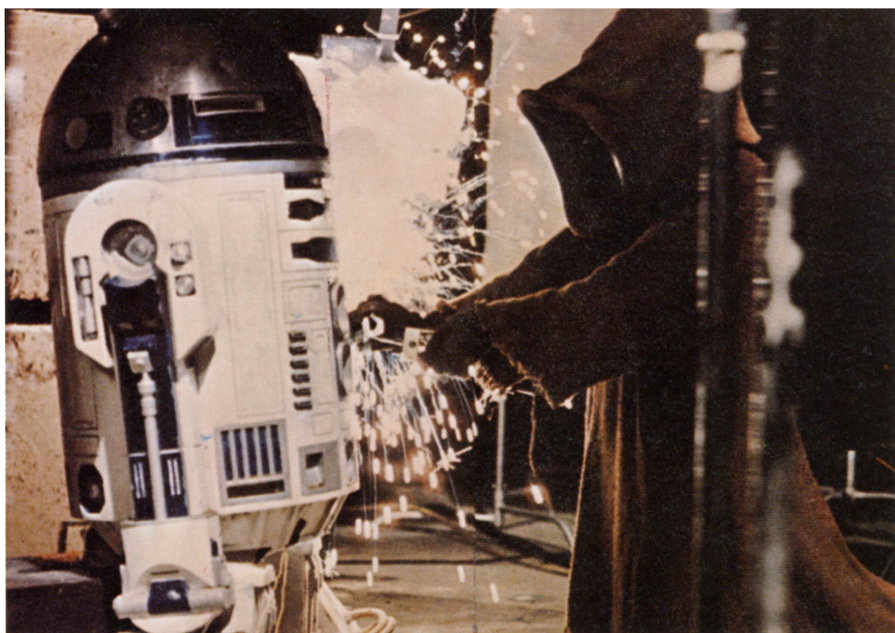
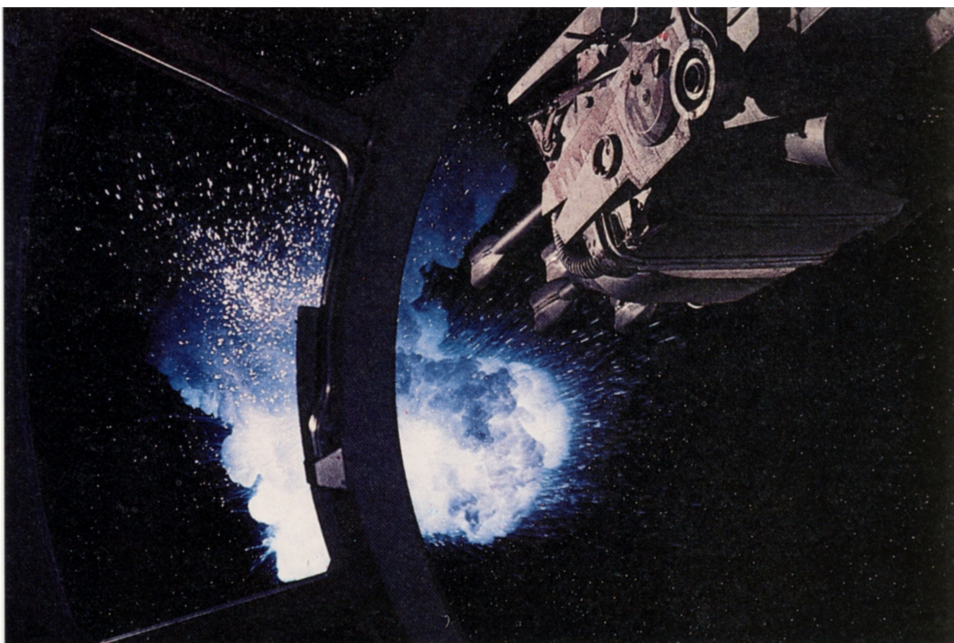
earliest ones that we created. It was shot at a camera speed of 300 frames per second. The first time I saw it I was amazed . . . it was just in pieces, slowly coming toward you, and it just kept going and going. . . .”

Explosions in outer space present a special problem since no one has ever seen one. There will, of course, not be any gravity effect, which should mean that the explosion would move out as a fairly uniform sphere. Most of the explosions designed for *Star Wars*, however, were designed for their spectacular effect rather than scientific accuracy. In space there would be no flame and no smoke. There would be “clouds of debris, glowing fragments, the ignition flash . . . at least as far as we can surmise. No one has actually seen a space station or ship blown to smithereens.”

“*This Island Earth* had a number of explosions or fireballs coming toward you, but some of the sparks were falling straight down and it really bugged the hell out of me. That’s why I insisted on almost every explosion being shot straight up from below—that was the key to the zero-gravity effect. The circumference of the explosion would fill the entire frame instead of dropping off to one side.”

The sequence of the attack over the *Deathstar* by the rebel fighters presented special problems. The ships had to be blasted while they were in motion relative to the surface of the *Deathstar* and in close-up. “About 13 ships were rigged by me and shot by Bruce Logan over at Producer’s Studio with their 45-foot-high ceiling. The ships were shot against a blue screen and mounted on long rods in front of a wind tunnel. When the fans were going full speed, the ship would still be stable, yet when the explosions went off, the debris and everything would be springing past it, making it look like the ship was actually moving.”

The working situation has a great deal to do with the quality of a finished product. There must be enough time to properly rig the models and establish close coordination between all members of the crew. “I’m not the kind of person that goes in and just does it all himself. I want to toss around ideas. I want to get feedback from a lot of people. While at Produc-



Top: Early test composite of TIE fighter explosion. Composite has not yet been color corrected.
Above: Viskocil rigged a “live-action” charge for the Jawa who welds the “restraining bolt” to R2-D2. The silver sparks are designed to suggest a welding effect.

er’s Studio, I would ask some of the gaffers and grips, ‘How did that look? What did you think of it? I would ask people I didn’t even know because I wanted to know their thoughts. . . . ‘Was it too big, or phony like a big 4th of July?’ I want to know people’s reactions. It’s this sort of caring that creates a healthy family situation with your crew, so that the best work gets done.

“You have to have *heart* in the motion picture industry. There are some directors, like Lucas, who are bringing back the old-fashioned matter of caring. Too many people today do not

care about the productions they are working on. They don’t care about the director, they don’t care about what he has in mind, they don’t care what the scene is all about . . . They just go in there and do their work like they were doing the laundry or something, and that’s it.

“Not everyone on the set has to share the same vision, but they should all be enthused about their work and care about the results. The audience cares about the results, they want to believe in what you’re doing, and it only takes a little care to make that come true.” ●

Building An Effects Shop For "The Empire"

Richard Edlund, Co-supervisor of Special Effects for "The Empire Strikes Back," discusses the challenge of building an effects facility from scratch, for what he calls "the greatest motion-picture project to ever hit the special-effects world."

For Richard Edlund, both *Star Wars* and *The Empire Strikes Back* began the same way—with an empty room. For *Star Wars*, it was an empty warehouse in Van Nuys, Calif., and for *Empire* a similar building in San Rafael had to be filled with photographic equipment and staff to film what Edlund believes to be "the greatest motion-picture project ever to hit the special effects world."

"Prior to *Star Wars*, I was working for Bob Abel's company. There I developed the 'candy-apple' glossy look and shot a number of ABC network logos. I had just finished a '7-Up' commercial that was very well received at the time (1975), when I heard that John Dykstra was interested in using me as first cameraman for an SF movie that George Lucas

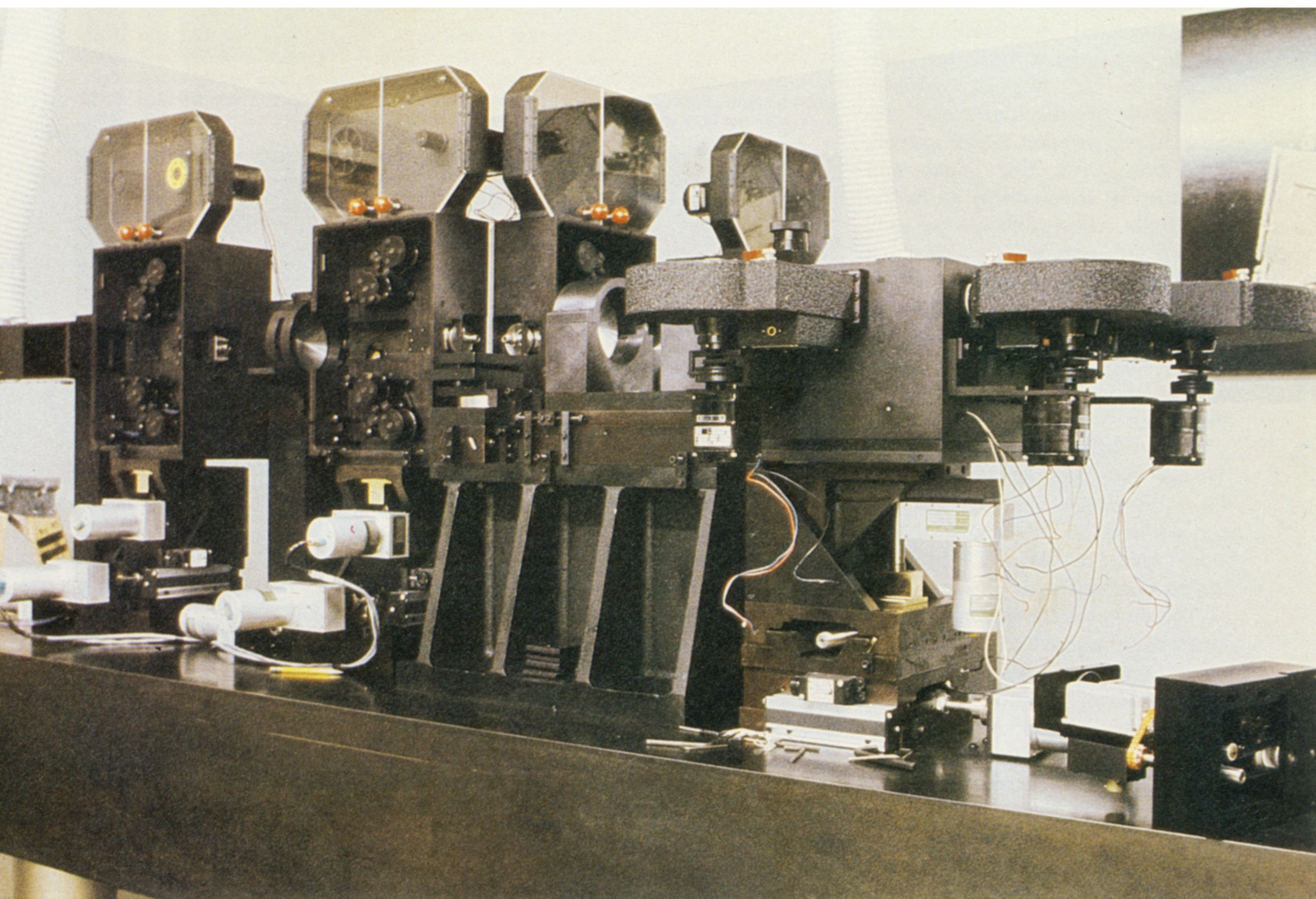
was going to produce and direct.

"My first task was to design the photographic system at Industrial Light and Magic, as George's [producer Lucas'] company came to be known. But at that time I.L.M. was just an empty building that we had to fill with equipment. In order to do that, we had to decide how we were going to do the film—what tools and processes would be required to transform George's script into visual images. Then, how would we acquire or build the tools and learn how to use them to finish the film?"

The first motion-control cameras that were built for *Star Wars* were conservative systems, since time was short and there was no leeway for fiddling with an overly exotic system. "the Dykstraflex," as that early camera came to be known, had to

Top: Empire Camera, built in three month's time is inspected by Richard Edlund, visual effects supervisor, prior to being sent to Norway.

Bottom: Quad printer in the process of being built.



work the first time it was plugged in.

"I was very happy with the way the camera system worked, how the effects looked and how the picture was received," remembers Edlund, who frankly was looking forward to another project with Lucas.

"I stayed with Dykstra's company a short while, working on an interim project (*Galactica*), with the proviso that if Lucas started the next film, I would be free to join him.

"The Lucas people have what I believe to be the almost ideal working atmosphere. They are extremely talented and know what they want. There aren't a lot of last-minute nonsensical changes and constant pandemonium. . . . The company operates in a straightforward, business-like way. Talented people are hired to do certain jobs; they do them and are recognized. It was a situation I had been looking for for many years.

New FX Locale

When *Empire* started up, Industrial Light and Magic moved to San Rafael in northern California. The location was chosen by Lucas because it was part of the country that he liked and felt at home in, but it is quite a way from the hub of film activity in Los Angeles. Artists, cameramen, modelmakers and animators would be asked to pull up roots and move north. But Lucas and Edlund were only interested in the best people. Many of the people they had worked with before—seasoned pros such as cameraman Dennis Murren, designer Joe Johnston and modelmaker Lorne Peterson, among others—jumped at the chance to work again with Lucas and the *Star Wars* saga.

"In San Rafael," Edlund explains, "we had the same situation as in Van Nuys—an empty building, but this time we had the experience of *Star Wars* behind us. We could build on that knowledge.

"The single most important piece of equipment that we had to add to our arsenal was an optical printer that was capable of very good resolution and was designed for doing composite work."

Each element of a special-effects shot is photographed separately and

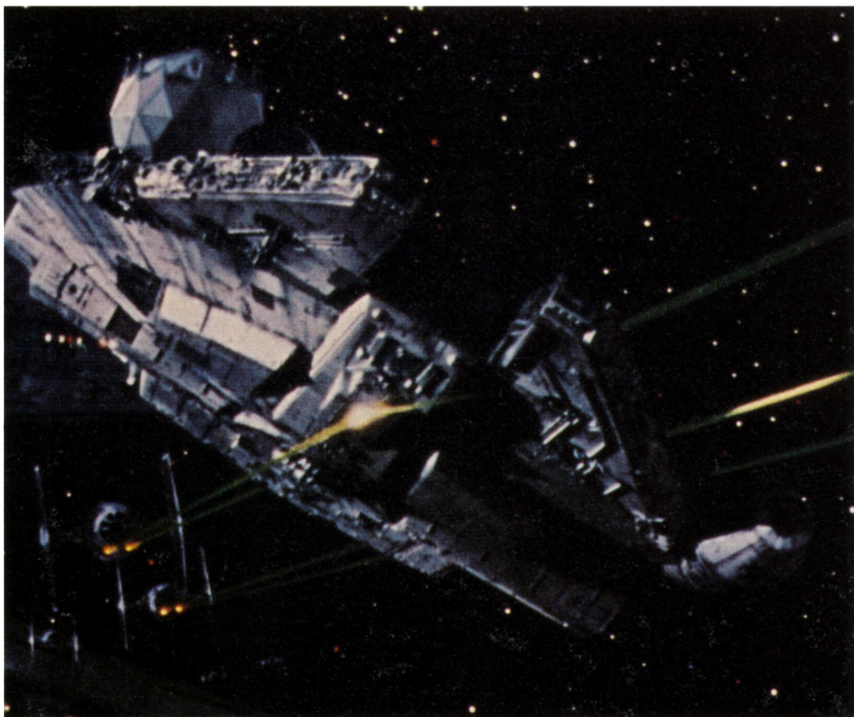
then combined into a single piece of film. If three TIE fighters are chasing the *Falcon*, then each TIE fighter and the *Falcon* are photographed on separate pieces of film; these separate pieces must then be combined with the appropriate background into a single piece of film. This compositing is done on the optical printer, and for such fine work a printer must operate with great accuracy.

"The printer which I specified and more or less designed and built," Edlund says, "is a four-headed (Quad

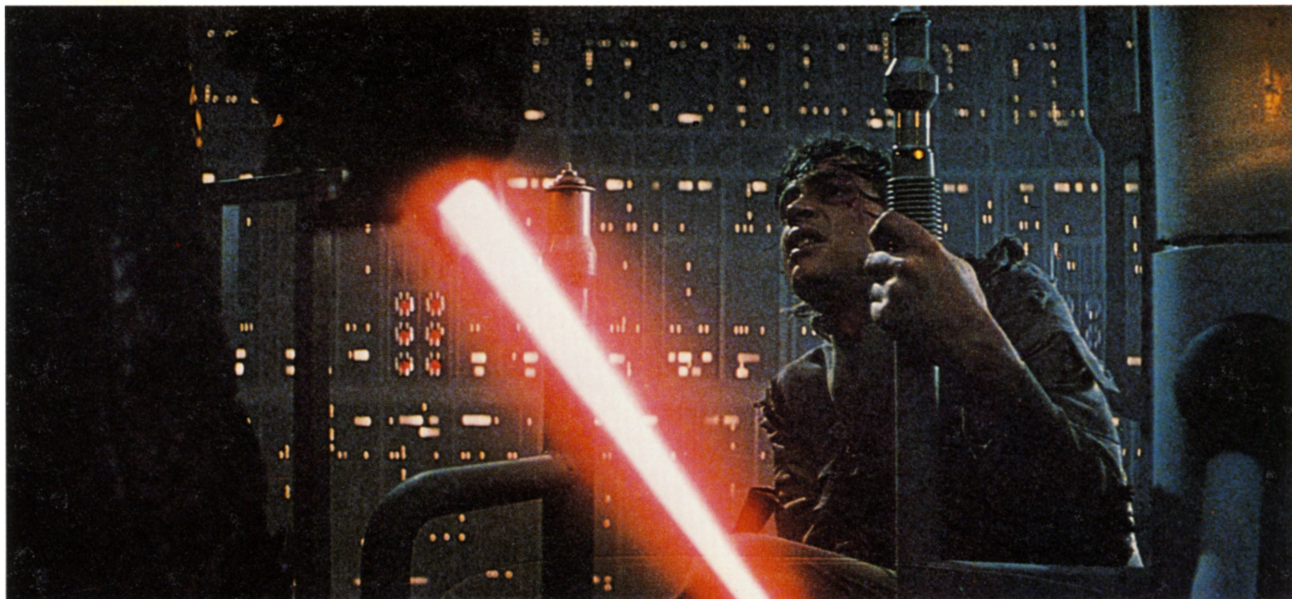
beamsplitter; that is, it has two projectors on each axis which are joined by a beam splitter. The splitter then sends those images through an anamorphic lens giving us a composited image in 35mm anamorphic format. All of our original effects photography is shot in VistaVision (sometimes called 'lazy-8' or horizontal 8-perf), which is reduced 2-to-1 when it is composited in the printer, so that the composited footage can be intercut with the live-action Panavision film."



Richard Edlund pulls back while technician Dick Dova supports the "luge" rig for the new high speed camera. A plexiglass case was built over the camera to simulate Luke's Speeder cockpit window for the POV shot as the Speeder crashes into the snow.



Motion control systems make such complicated sequences as this chase feasible.



Lightsaber effects were added optically in post production.

One of a Kind

The ILM "Quad" printer is probably the only one of its kind and quality in the world. "There are no problems in particular with designing this sort of system, generally," says Edlund, "though it can't be built or designed with 'off-the-shelf' optics. The optical path [of light through the lens] was completely designed from scratch before we settled on how the lenses would be mounted or what the configuration of the printer would be. So, it was basically a matter of starting with the most important element of the printer (the optical path), designing that and then wrapping the mechanics and electronics around it. This turned out to be extremely successful and I believe it to be the best printer in the world."

The lenses are of such high quality that the line resolution of the Nikon lenses used on the motion-control camera is *exceeded* by the anamorph on the printer. David Grafton was the designer of the anamorph lens, which was manufactured by J.L. Wood.

The printing functions of the Quad printer are all computer-controlled. "Jerry Jeffress and Al Miller are sort of the grandfather of the motion-control systems here in Hollywood. Jerry is on staff here in San Rafael, now," Edlund explains. "He has designed the system so that it is micro-processor based and completely changeable at the will of the operator.



Richard Edlund, Irv Kershner and Brian Johnson discuss ILM's custom built Quad Printer in the Optical Department at the San Rafael facility.

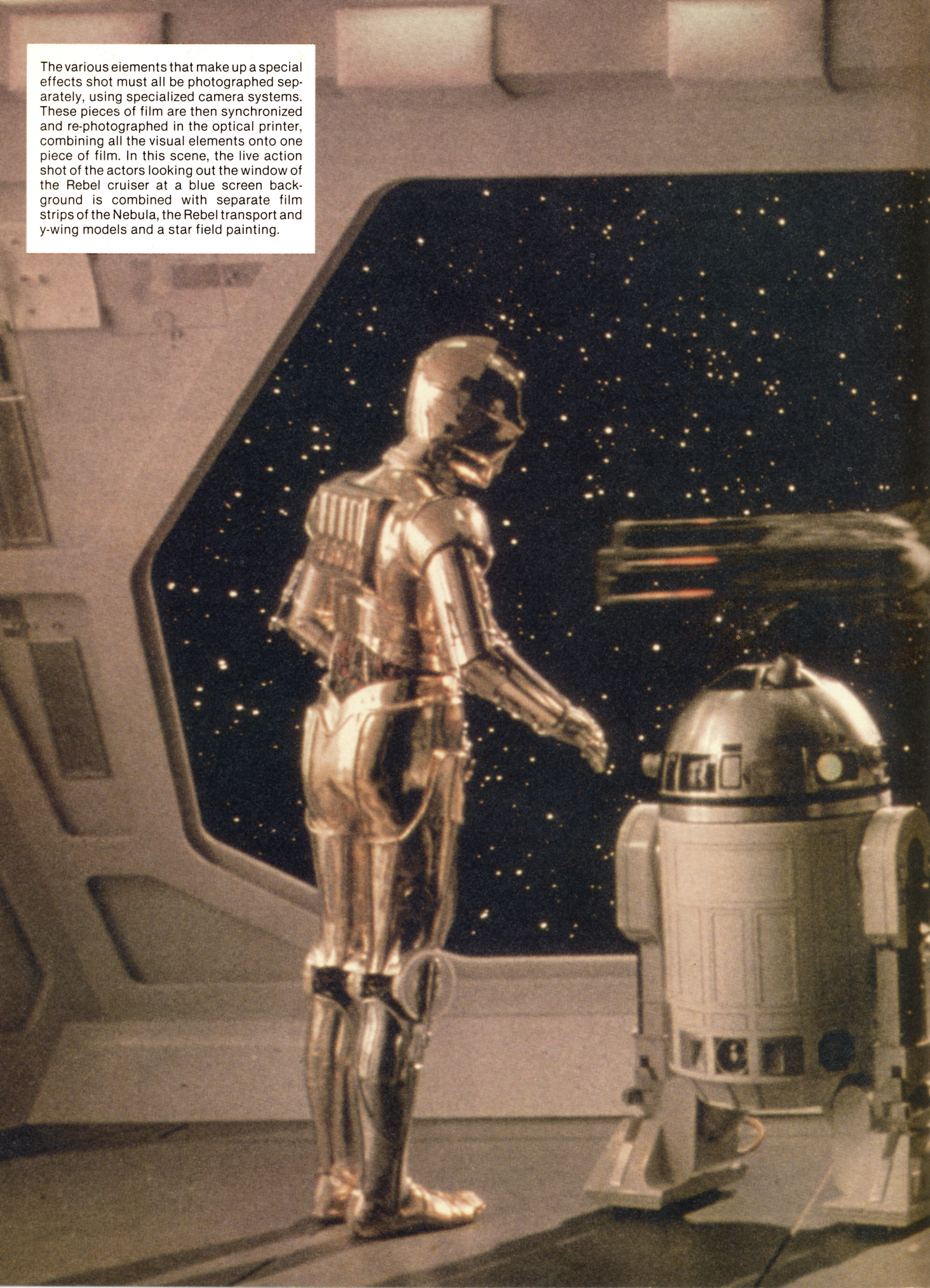
The equipment has flexibility. We aren't saddled with something that can't be changed without completely rewiring the entire device. If somebody comes up with something else they want the system to do, the software can be rewritten, loaded into the computer so that the printer may be off-line for only five or 10 minutes.

ILM's commitment to the VistaVision format has gone so far as to have new VistaVision cameras built. "We had two cameras built for *Empire*. One is a motion-control camera designed for location work. It simply records the movements of the camera, pans and tilt, so that when

the miniatures are added the recorded moves can be fed into another camera to duplicate the moves in scale. In this way, miniatures and live action can be combined without having to rely on static tied-down camera shots.

"The other VistaVision camera is a high-speed camera, which the Mitchell Company built for us," Edlund explains. "It can operate at about 96 frames per second, but we are working on a redesign of part of the movement that will give us even higher capability. Both cameras are reflex, so that you can see exactly what you're shooting.

The various elements that make up a special effects shot must all be photographed separately, using specialized camera systems. These pieces of film are then synchronized and re-photographed in the optical printer, combining all the visual elements onto one piece of film. In this scene, the live action shot of the actors looking out the window of the Rebel cruiser at a blue screen background is combined with separate film strips of the Nebula, the Rebel transport and y-wing models and a star field painting.







Sky plate, models and motion control all add up to a shot of breathtaking beauty and excitement.

The Ultimate System

That brings the total to three motion-control cameras—the two originally built for *Star Wars* and the new VistaVision sound-speed built for *Empire*. But Edlund is looking to the future, and another system is being built which has been dubbed the VistaCruiser. This new camera will have an 80-foot track (instead of the 42-foot track that the current motion-control system utilizes) with improved motion-control capability, increased film capacity, a better follow-focus system and video viewfinder.

Ultimately, Edlund hopes that a motion-control system can be developed that is compatible with every piece of camera equipment, including the Oxberry animation stands and the optical printer. If all of the cameras and printers can “talk” to one another, the range and flexibility of the entire system will be greatly increased. For example, if for some reason the track was too short for the motion controlled camera, the move could be completed in the printer at the same rate, at the press of a button. Or it may be necessary to interlock a move on the model stage with the matte camera, so that a model can make a complex move across a matte painting.

The possibilities are endless; and that's just the sort of system that

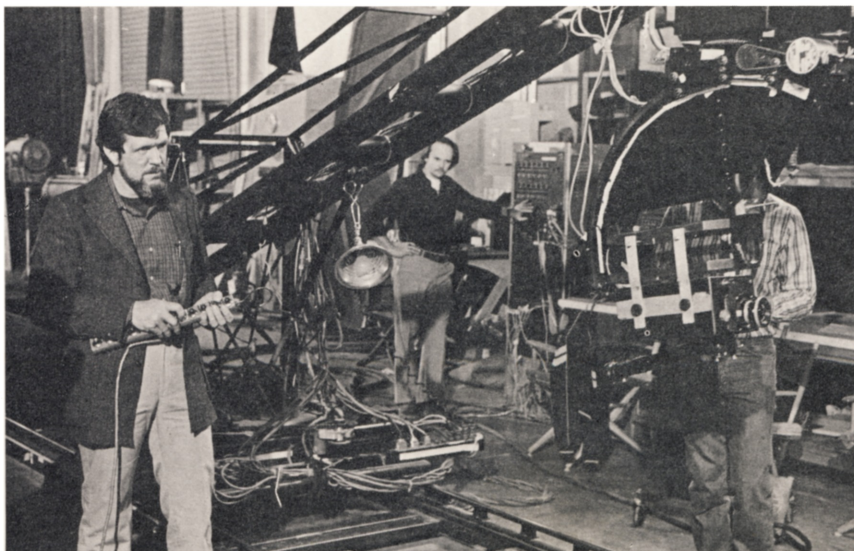
Edlund is seeking to create. All of the equipment is designed to be as easy and as fun to use as possible. “We don't want our people to carry around 1,000 lb. weight just to get a shot. If the equipment is difficult and cumbersome to use, then the tendency will be to use only the easiest parts of it; people will tend to avoid the more complex shots because of the pressure and the amount of work.

“*Empire* is probably two orders of magnitude more difficult than *Star Wars*. In *Empire*, we have a far greater variety of situations to deal with—it's much more than just a bat-

tle in space, which made up a good portion of *Star Wars*. There are a tremendous variety of shots, most of which have depended on the development of little techniques in lots of areas. To get all of these techniques developed, working and looking good on the screen has been a challenge.

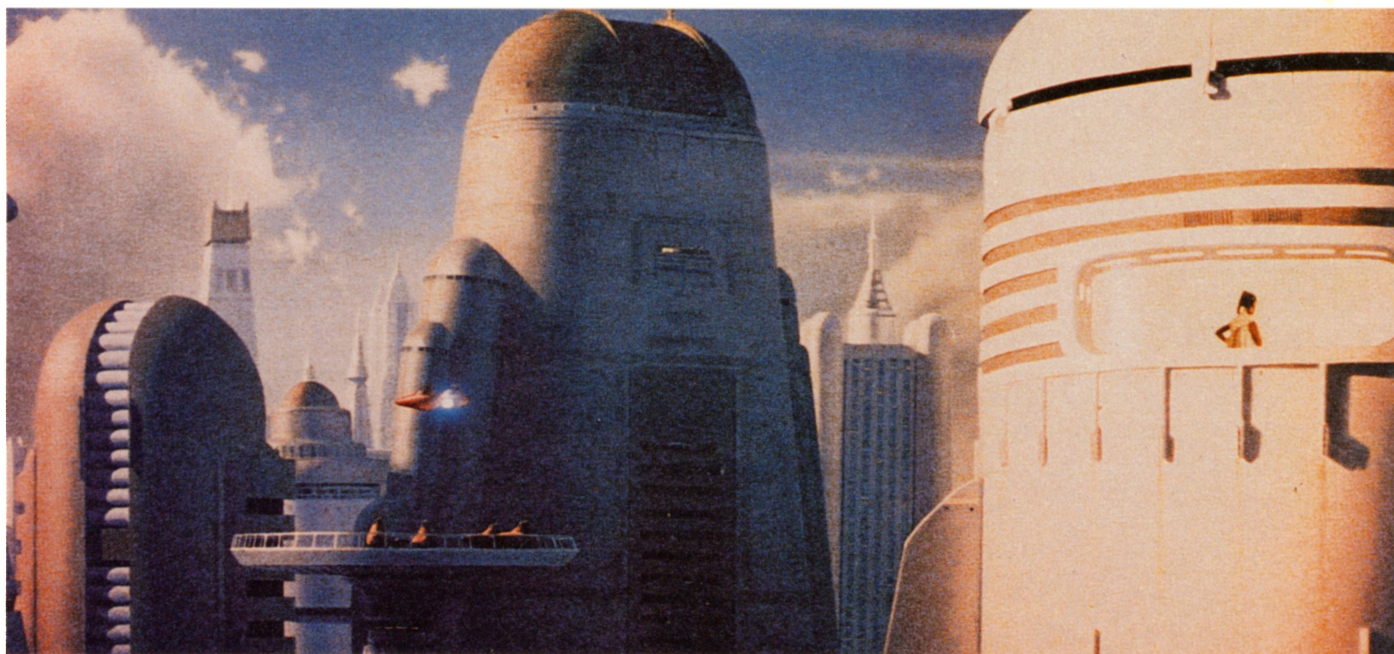
“For example, in the snow battle sequence, it was very difficult to generate a traveling-matte system that was capable of producing matte-line-free shots. It's a technical problem, but there's an esthetic too.

“You have a situation in which you have to create a shot that can only



Richard Edlund manipulates the remote controlled motion control camera in the new effects facility.

PHOTO © 1980 LUCASFILM LTD



Note the live action insert in this close-up shot of Bespin.



Gary Kurtz and Irv Kershner assemble the meticulous shot for shot storyboards from *Empire*.

exist through the use of trick photography—sometimes using painted backgrounds, sometimes using plates that were shot in Norway intercut with live-actions footage. They have to match.

“People have seen snow, they know what it looks like; they’ve seen the live-action footage, so there can’t be any giveaway with the effects footage. Even the atmospherics of the miniatures have to match the live action.

“What you can get away with in a deep space shot is phenomenal, since nobody’s ever been there, no one’s going to question you about how things look on the screen. But when you’re trying to pull the wool over the eyes of a 10 year old, who is your severest critic, you’re in trouble. He’s seen millions of feet of film and he doesn’t care why something doesn’t look right

on the screen, he just knows it looks funny and he’s not going to buy it . . . and that disrupts his tension and involvement in the drama. The material has to look real.”

Tricky Crash Scene

Edlund then explains another tricky effects sequence. “There is the shot in which Luke crashes in his snow speeder. The first part of the shot is stop-motion created by Phil Tippet and John Berg, with the camera coming almost to the ground. I had to shoot a high-speed sequence of 30 or 40 frames that would take him from a few feet off the ground into a crash from an over-the-shoulder point of view. So it actually looks like he is crashing into the snow and settling. And *that* has to match the next shot, which is a plate of him getting out.

“We are constantly in a situation in

which you have to match both ends against the middle. You have to shoot the middle which has to match both ends of shots that someone else has done. In this case, it was a relatively difficult-to-control, high-speed shot with blowing snow and flurries.”

But even though the planetbound shots created a whole new area of challenges, the deep-space shots became very complex in *Empire*. “The asteroid sequence has probably got some of the most complex blue-screen shots ever filmed. There is one shot that has 20 separately photographed elements in it. All of which have to match. There are individual asteroids, the *Millennium Falcon*, three TIE fighters with lasers going, an asteroid belt in the distance (which is a multi-plane shot), four paintings, shadows moving across the asteroids There are easily 100 pieces of film necessary to composite this shot, considering all of the separations and mattes and roto-scoped elements.

“Surprisingly, it did not take that long to assemble the scene on the Quad printer, which is a tribute to Bruce Nicholson, who has done an unbelievable job of putting together something like 420 effects shots. Our re-comp [re-compositing] rate is maybe a third of what we had to do on *Star Wars*. There has been a lot of experience gained and a lot of techniques re-

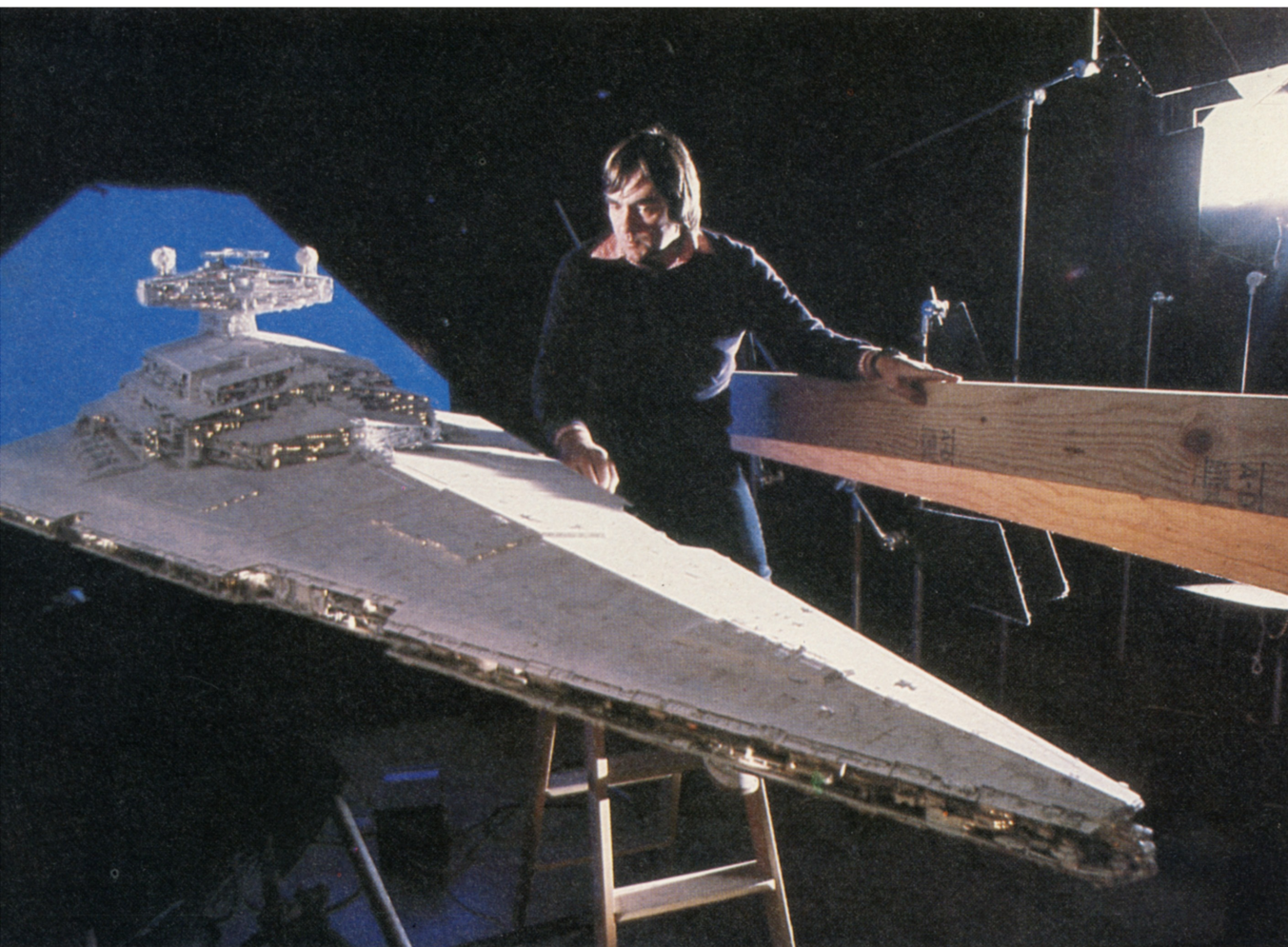


PHOTO © 1980 LUCASFILM LTD.

Brian Johnson pauses for a moment beside the model of an Imperial cruiser. Johnson shared the effects supervisor credit with Richard Edlund.

finished since *Star Wars* and our new equipment is precision equipment, so that instead of having to re-comp a shot eight or nine times to get it right, we are able to do it, in a lot of cases, only three times.

"There are always the headache shots, which are sometimes the real 'simple' shots, but for some reason, the god of matte lines is not on our side, or the color balance is elusive or something like that."

Priority System

Edlund has a priority system for judging special-effects footage. The first commandment in the laws of special effects states that "the color balance has to be right. The matte line can be the size of a halo," believes Edlund, "but you'll have a better chance of getting by than if it has a pink cast, for example, or green on one of the elements."

"Then comes matte lines. If you

pass those two obstacles, you must deal with problem of relative quality. How sharp, how grainy is the element being matted in comparison to the rest of the plate? That takes a lot of experience and time to get it right."

For the future, Edlund is pleased to be in a work situation with an on-going facility. He can continue to build and refine the system that has helped bring the Lucas vision to the screen. Here, too, says Edlund, "the cameramen have a good deal of autonomy. Everyone here has a talent that they were hired for and everyone exercises their own creative judgment in doing shots. Our by-word here is generally for people to take the ball and run with it."

Soon Edlund hopes to have four or five additional motion-control cameras in VistaVision format up and running. "More cameras to use means that we can devote more time to a particular shot. A guy can do a

test on a shot and then walk away—leave that camera where it is, go on to another camera and work for another shot. In this way, we can develop each shot more carefully, without the fear of tying the equipment up for too long.

"We are going to build another printer, not another Quad, but a printer to handle other jobs. We will build a rear-projection matte system for the matte artists. And we are beginning to make inroads into electronic compositing. . . ."

Richard Edlund has been spending more time in a supervisory position, but he has been able to get to the camera for the highspeed shots and some of the planet shots. "I've gotten to the camera maybe about 20 percent of the time, but most of the job has been trying to keep the style of the photography consistent and integrated, and I must say I'm very happy with my current position."

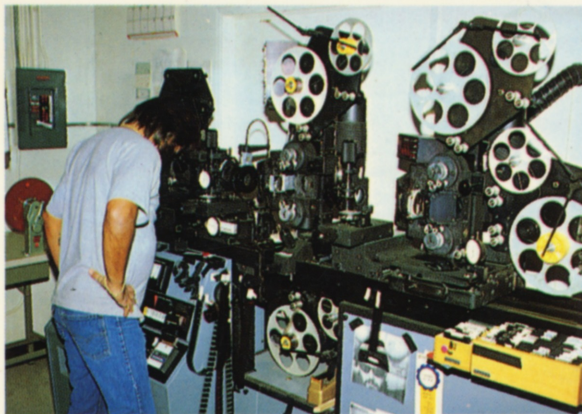
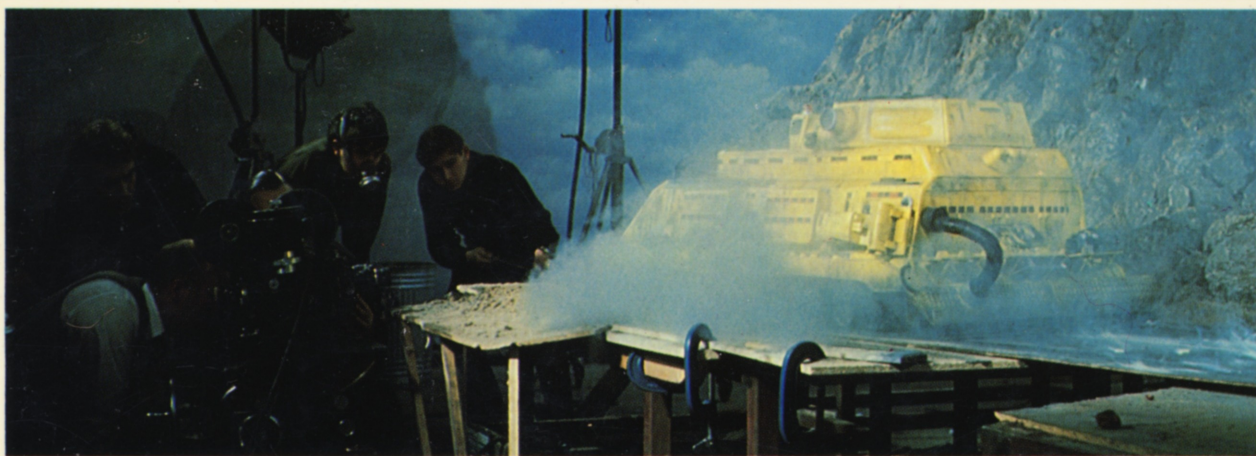
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